CONNECTING SCIENTISTS AND ADULT LEADERS THROUGH TECHNOLOGY TO FURTHER AUTHENTIC SCIENCE INQUIRY BY YOUTH

THESIS

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Connecting Scientists and Adult Leaders Through Technology to Further Authentic Science Inquiry by Youth

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Abstract

This paper shares the results of a recent study exploring the preferences of potential adult leaders towards the use of internet technologies to support connections with professional scientists and facilitate authentic scientific inquiry among middle-school aged youth engaged in citizen science research. Using the University of Minnesota Extension's project, Driven to Discover: Authentic Inquiry through Citizen Science, as context for the study, the researcher interviewed licensed teachers and informal science educators to answer the research questions: 1. How do adult leaders describe the potential for using web-based technology as a means to achieve the scientist contribution to youth-based authentic science inquiry? 2. How do adult leaders perceive plans to develop a website to facilitate the ongoing relationship of scientists, adult leaders, and youth? What do they perceive as needs and barriers for using this planned website? What website characteristics would encourage them to use this planned website? Results suggest that participants see the potential for web resources to support inquiry work with youth and facilitate connections to scientists.

Keywords: science inquiry, education, technology, citizen science

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Chapter 1: Introduction

Background

University of Minnesota Extension

The University of Minnesota Extension (UME) is a 100-year-old partnership between the University and federal, state and county governments. It serves as an outreach arm of the University to provide scientific knowledge and expertise to the public. Founded in 1851, the University of Minnesota was designated a land grant college in 1867, joining the nation's more than 100 land grant colleges and universities with a mission to engage in teaching, research and extension (Hadiaris, 2009). According to the University of Minnesota's website, land grant institutions use Extensions to "extend" their resources to address critical public issues through non-formal, non-credit education (University of Minnesota Extension, 2011b).

Four key pieces of legislation from the late 1800's and early 1900's established the foundation for Extension. The Hatch Act of 1887 provided annual funding for agricultural research through State Agricultural Experiment Stations, which were established by colleges, universities, or agricultural departments within the higher education institution (University of Minnesota Extension, 2009b). In July of 1862, President Lincoln also signed into law the Morrill Act, which allowed for the creation of land grant universities. In 1909, the Minnesota State Legislature passed an act "to create and maintain a division of agriculture extension and home education in the department of agriculture of the University of Minnesota, to provide for the publication and distribution of home education bulletins and appropriating money therefor[e]" (University of Minnesota Extension, 2009b, para. 4). The Smith-Lever Act of 1914 established a Cooperative Extension Service in association with each U.S. land-grant institution

and provided federal funding for extension activities (University of Minnesota Extension, 2009b).

While current programs funded through the Smith-Lever Act continue the traditional extension focus on agricultural and rural issues, the focus has been broadened to include the Expanded Food and Nutrition Education Program, Children, Youth and Families at Risk and programs to support the "development of practical applications of research knowledge…in agriculture, uses of solar energy with respect to agriculture, home economics, and rural energy" (United States Department of Agriculture, 2009, Sec.1 [7 U.S.C. 341]). University of Minnesota Extension currently focuses on five key areas:

1. Environment
2. Food and agriculture
3. Communities
4. Families
5. Youth (University of Minnesota Extension, 2011b)

Environmental education (EE) is included under the category of environment. University of Minnesota Extension promotes natural stewardship and understanding by helping "…Minnesotans explore, understand and conserve their environment. Through our research-based programs and products, we work with educators and volunteers to support quality environmental service and teaching about the environment" (University of Minnesota Extension, 2011a, para. 1).

Driven to Discover: Enabling Authentic Inquiry through Citizen Science

The Driven to Discover (D2D) project incorporates multiple aspects of Extension work through its focus on EE and youth development. Funded by a grant from the National Science Foundation, D2D seeks to expand citizen science to middle- school youth by enabling them to design, carry out, and report on their personal research questions while being supported by science advisors from the University of Minnesota (University of Minnesota Extension, 2008). Driven to Discover supports youth development by giving project participants the freedom and responsibility to design their own projects, allowing students to gain a greater understanding and appreciation for science, and grow to see themselves as scientists (University of Minnesota Extension, 2008). Oberhauser, Lorek Strauss, Meyer, and Larson Nippolt (n.d.) state that "youth learn science better by engaging in inquiry-based activities, and that K-12 and ISE [Informal Science Educators] educators become more effective research mentors when they themselves engage in research and interact with scientists" (p. 3); therefore while the ultimate beneficiaries of the D2D project are middle-school youth, the direct beneficiaries are actually the varied group of research team adult leaders (Oberhauser et al., n.d.)

The Driven to Discover: Authentic Inquiry through Citizen Science project plans to achieve its goal of "engaging middle school aged youth in authentic science inquiry" (p.1) in two phases (Oberhauser et al., n.d.). Phase 1 will encompass Years One through Three and Phase 2 will include Years Four and Five. The project, currently in Year 2 of Phase 1, the grounded theory phase, has focused on developing research teams that consist of adult leaders, youth and scientists which will engage in youth-initiated inquiry based on their involvement with citizen science research through existing programs such as the University of Minnesota's Monarch

Larva Monitoring Project and Monarchs in the Classroom or Cornell Lab of Ornithology's Project Feeder Watch and E-bird programs (Oberhauser et al., n.d. a). Through extensive support and evaluation of the current Phase 1 research teams, Extension staff will "deconstruct relationships that foster authentic inquiry, developing an understanding of key elements that lead to full engagement in the research process" (Oberhauser, et al., n.d. a, p. 1). Initial data from Year One indicate that research teams tended to fall into either of three categories for success in facilitating youth in science inquiry:

1. Low Challenge – teams operated smoothly. Youth participants tended to accomplish high-caliber investigations.
2. Moderate Challenge – teams operated with some challenges. Youth participants were mixed in their accomplishment of investigations. Some teams worked together on one or two group investigations that were youth-driven.
3. High Challenge – teams operated with significant challenges. Youth participants tended to finish the project without completing/presenting investigations. (Oberhauser, et al., n.d. b, p. 11).

Based on a comparison of these categories of teams, D2D project leaders have created a basic model to illustrate current understanding of relationships among factors described above which "conceives the adult leaders (encompassing both the leader and scientist during Phase 1 of the project) as the principal engine in this model" (Oberhauser, et al., n.d. b, pg.11). The model indicates that the skills and aptitudes that adult leaders employed to successfully facilitate their research teams were closely interconnected with youth motivations and interests in the respective

citizen science project in which they were participating. In turn, the facilitation strategies utilized by adult leaders were interlaced with the additional factors of group formulation, citizen science project, and setting for team meetings and varied greatly depending on the experience and background of the adult leader (Oberhauser, et al., n.d. b). The process of revising the project curriculum and grounded theory will be ongoing and will reflect the emergent understanding from Years Two and Three.

The second phase of project implementation will focus on facilitating dissemination of the D2D model of authentic science inquiry to broader audiences of youth leaders and citizen science practitioners (Oberhauser et al., n.d. a). During Phase 2 of the project, lessons from the formative assessment will be used to develop a "platform for self-directed learning" (p. 1) that will train and support adult research team leaders to compensate for the transitioning role of the scientist from integral team member to a less directly involved adviser (Oberhauser et al., n.d. a). The proposed D2D Phase 2 hybrid learning environment embraces the concept of open-ended learning environments (OELEs), which support student-centered pedagogies and theories by allowing the learner to make decisions about how, what, and when to learn thereby increasing learner investment in the learning experience and self-efficacy (Veletsianos & Doering, 2010). In OELEs, the role of the teacher is to provide scaffolding through online experiences that support students' real-world experiences (Veletsianos & Doering, 2010).

Purpose Statement and Research Questions

As part of this Phase 2 transition, a website will be developed with the purpose of facilitating, supporting and training current and future adult leaders in youth-based authentic science inquiry in the context of citizen science. The purpose of this study was to determine

website characteristics that would motivate and enable adult leaders (formal teachers, youth leaders, and ISE educators) to use web-based technology to support youth in the authentic science inquiry process.

Aligned with the concept of Vygotsky's zone of proximal development is the idea that what an individual learner is able to accomplish is increased when supported by "capable others" (p.496) who have progressed further towards an understanding of the target learning concept (Reid-Griffin & Carter, 2004). In the D2D citizen science model, the role of 'capable other' is filled not only by adult leaders but also by professional scientists. Scientists provide guidance for adult leaders and youth participants striving to conduct citizen science grounded in authentic inquiry primarily through in-person visits to the research teams. According to Salomon, Globerson, and Guterman (1989) to "qualify as pertaining to a zone of proximal development the guidance provided must become internalized such that the individual can perform on a higher cognitive level independently of the social interaction" (pg. 620). Salomon et al. assert that the three basic elements that occur during a social interaction that may lead to improved mastery of a cognitive skill (modeling, activation of a mental operation, and guidance) can be present in other tools outside of interpersonal interaction, including well-designed computer tools (1989).

Thus, this study sought to answer the following questions:

1. How do adult leaders describe the potential for using web-based technology as a means to achieve the scientist contribution to youth-based authentic science inquiry?
2. How do adult leaders perceive plans to develop a website to facilitate the ongoing relationship of scientists, adult leaders, and youth? What do they perceive as needs for

and barriers to using this planned website? What website characteristics would encourage them to use this planned website?

Based on the information gathered from potential adult leaders, this study provides recommendations for design and implementation of online resources for adult leaders that emphasize authentic inquiry and support connections between scientists and youth. The University of MN Extension will use the results of this study in their efforts to develop a web site that is used by adult leaders to support youth-based authentic science inquiry in the context of citizen science.

In "Long Term Student Experiences in Hybrid, Open-ended and Problem Based Adventure Learning Program," Veletsianos and Doering observed that a majority of educational technology interventions are either short-term or short-lived due to the rapid rate that emerging technologies render current and 'new' tools obsolete (2010). However, they also found that in their population of middle school learners, sustained interest in the learning experience was not merely tied to the content but also to the activities built around the content and the availabilities for interaction and participation by the learners, most of which could not have been possible without the use of social technologies (Veletsianos & Doering, 2010). Hybrid learning environments allow teachers to scaffold real-life experiences with online resources in a way that allows the learner to be self-directed and thereby supports student-centered pedagogies (Veletsianos & Doering, 2010). By bringing together multiple elements (e.g. collaborative activities, live chats with experts, real-time trail reports) into the learning process, the students reported experiencing a dynamic open-ended learning experience that individuals or groups of individuals could experience via any means they desired (Veletsianos & Doering, 2010).

The potential beneficiaries of this research are middle-school aged youth participating in citizen science inquiry programs based on the D2D model, as aligned with the desired outcomes of the D2D project and grant proposal (University of Minnesota Extension, 2008). Since the adult leaders will serve as gatekeepers for the routine activities of the individual research teams and deliverers of the project curriculum, it is important to understand their perceived needs and barriers towards the use of online resources to support the relationship between youth and the scientist-mentor. Therefore, the research sample consisted of potential adult leaders participating in the Driven to Discover: Enabling Authentic Inquiry through Citizen Science at research sites throughout the state of Minnesota.

Significance

In their recommendations for further study, Veletsianos and Doering (2010) suggest that:

> Our field should actively seek ways to design engaging learning experiences that are sustained over time. To do so, future work should investigate how to bridge the gap between classroom instruction and out-of-classroom experiences in locations of interest. Implicit to this idea is the notion that new and emerging technologies allow and foster creative explorations of out-of-the-classroom settings. (p. 291)

The significance of this study is in discovering potential barriers and participant preferences regarding web-based project training and support for the D2D model of authentic science inquiry through citizen science. Reid-Griffin and Carter (2004) have identified that due to the complexity of using technology as a learning tool, a critical question that emerges is how to effectively structure instruction to allow for the infusion of educational technology into the curriculum. This study sought to better understand how to maintain and support the connections

among the scientists and the adult leaders and youth which form the basis for the research teams and to provide recommendations for website design which align with the preferences of participants and meet the training and curriculum goals of the D2D project.

Definition of Terms

Environmental Education

Environmental education includes research-based programs and products that support quality environmental service and teaching about the environment which help enable Minnesotans to explore, understand, and conserve their natural environment (Environmental Science Education Team, 2010).

Educational Technology

Educational technology as a discipline of study is the "the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources" (Richey, 2008, p. 24).

Citizen Science

Citizen science is the use of partnerships between volunteers and scientists to answer real-world questions via observations made by the volunteers using protocols defined by the scientists (Oberhauser et al, n.d.).

Science Inquiry

Inquiry is a "logical and rational order of steps by which scientists come to conclusions about the world around them. Scientific inquiry is not a rigid set of procedures, but rather a broad approach to investigation that begins with questions…and leads an investigator to reasoned, evidence-based answers to those questions" (Lorek Strauss, 2011, p. 1).

Needs Assessment

A needs assessment is the systematic appraisal of type, depth, and scope of problems as perceived by study targets or advocates, which results in the determination of clear goals and priorities for program development (Cook, 1989).

Limitations

This study is constrained by the following limitations:

1. The number and demographics of actual research participants differed from target research participants. Desired participant demographics included equal numbers of licensed teachers, informal science educators, and youth development leaders. Actual participants included 3 licensed teachers, 6 informal science educators, and zero youth development leaders.

2. Due to the sampling methods and screening procedures of potential participants, participants' perception and definition of the inquiry process varied and may not have aligned with the definition and process steps of inquiry employed by D2D.

Assumptions

The author made the following assumptions at the onset of this study:

1. When properly utilized and supported, web-based educational tools are an effective means for learning and communication.

2. Adult leaders serve as gatekeepers to youth participants of research teams during the science inquiry process due to their position of authority within the research team and as decision-makers regarding the extent of implementation of the D2D curriculum.

3. The relationship of professional scientist as mentor to both the adult leaders and youth throughout the science inquiry process has a profound and positive impact on the self-perceptions of both adults and youth as ‘real scientists.’

Chapter 2: Review of the Literature

Environmental Education

In 1969, Stapp defined environmental education by stating, "Environmental education is aimed at producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution." (Stapp, W.B, et al., 1969, p. 34)

The Tblisi Declaration, put forth by the United Nations Education, Scientific, and Cultural Organization (UNESCO) in cooperation with the U.N. Environment Programme (UNEP) during the Intergovernmental Conference on Environmental Education established international goals for the advancement of environmental education and further defined environmental education. The conference established goals, objectives and guiding principles for environmental education. The *goals* of environmental education are:

1. to foster clear awareness of, and concern about, economic, social, political, and ecological interdependence in urban and rural areas;
2. to provide every person with opportunities to acquire the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment;
3. to create new patterns of behavior of individuals, groups, and society as a whole towards the environment.

The categories of environmental education *objectives* are:

Awareness—to help social groups and individuals acquire an awareness and sensitivity to the total environment and its allied problems.

Knowledge—to help social groups and individuals gain a variety of experience in, and acquire a basic understanding of, the environment and its associated problems.

Attitudes—to help social groups and individuals acquire a set of values and feelings of concern for the environment and the motivation for actively participating in environmental improvement and protection.

Skills—to help social groups and individuals acquire the skills for identifying and solving environmental problems.

Participation—to provide social groups and individuals with an opportunity to be actively involved at all levels in working toward resolution of environmental problems. (UNESCO, 1977)

Environmental education helps advance the goals of environmental literacy, which adds attitude and behavior components to the learner's environmental knowledge base. Attitude and behavior are difficult areas to address and require commitment and motivation on the part of the individual learner. According to Athman and Monroe (2001), this commitment and motivation often begins with an awareness of one's immediate surroundings.

The Wisconsin Department of Public Instruction (2010) defines environmental education as:

> A lifelong learning process that leads to an informed and involved citizenry having the creative problem-solving skills, scientific and social literacy, ethical awareness and sensitivity for the relationship between humans and the environment, and commitment to engage in responsible individual and cooperative actions. By these actions, environmentally literate citizens will help ensure an ecologically and economically sustainable environment. (para. 6)

In his book, *Last Child in the Woods: Saving Our Children from Nature-Deficit-Disorder* (2008), Richard Louv coined the term, *nature-deficit disorder* which describes phenomenon and increasing cost to children as they are increasingly deprived of direct contact with nature and the experience of unstructured free play in the out-of-doors (Louv, 2008; Driessnack, 2009). While some attribute this divide to the increasing prevalence of technology in our daily lives, others see technology as a means to bridge the gap.

Educational Technology

In a study of youth in 1999, data showed that youth spend an average of 6.5 hours a day with electronic media and research has shown that educational technology can improve academic achievement, students' attitudes towards learning, and self-concept (Driessnack, 2009; Schacter, 1999). In a more recent study by Lenhart, Hitlin, and Madden, their research showed that in 2004, 87% of teens , aged 12-17, in the United States use the internet (2005). Of that 87%, approximately 21 million youth, 11 million of them access the internet daily (Lenhart et al., 2005). The Board of Directors of the Association for Educational Communications and Technology has recently redefined the field of educational technology as "the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources" (Richey, 2008, pg. 24). Educational technology applications for learning can include hardware, software, and web-based programs. Research supports the idea that "[digital] tools can serve as mediators of higher learning supporting the construction of knowledge by enhancing the interactions occurring in the classroom environment and culture" (Reid-Griffin & Carter, 2004, pg. 497).

Today's students are ahead of teachers in using technology to support learning and this creates a "digital disconnect" between students and educators (Engstrom & Jewett, 2005, pg. 12). In "Digital Natives, Digital Immigrants" Marc Prensky describes today's youth as native speakers of the digital language of computers, video games and the Internet (Prensky, 2001). He argues that digital natives may use the same technology as immigrants (those who have not grown up using digital technology their whole lives) are but using it differently (Prensky, 2004). In fact they may actually think differently due to the amount of digital inputs they are processing and therefore require different methods of teaching and learning (Prensky & Berry, 2001). Dyrud, Worley, and Flatley (2005) found that educational technology such as blogging was an excellent medium for student-centered learning and that students using blogs tended to be more attuned to their assignments and to their group members. Additionally, students reported being more motivated as a result of using the blog (Dyrud et al, 2005, pg. 79).

While Prensky's research has been expanded on to include a larger continuum of digital users, there continues to be a gap between the depth of use that students are comfortable using and what teachers are comfortable teaching. Engstrom and Jewett's (2005) research indicated that while the majority of teachers in their study had experience both with using technology for research and inquiry-based learning, they needed additional training and practice in combining the two to prompt student's critical thinking (pg. 14).

In 2007, The International Society for Technology in Education (ISTE) created and published standards to guide the use of technology in education and classrooms. ISTE adopted three different sets of guidelines for technology use based on the target audiences of students, teachers, and administrators. Teachers and administrators can use these National Education

Technology Standards, or NETS, to provide specific educational outcomes for web-based activities and to ensure that technology is being used appropriately to support learning. The standards for students cover six general topic areas including creativity and innovation, communication and collaboration, research and information fluency, critical thinking, problem solving and decision-making, digital citizenship, and technology operations and concepts. These student standards, specifically standards 1-4, will help inform the eventual recommendations to D2D staff regarding the design and features of the proposed website. The four NETS for students that impact this study are:

1. Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students:

a. apply existing knowledge to generate new ideas, products, or processes.

b. create original works as a means of personal or group expression.

c. use models and simulations to explore complex systems and issues.

d. identify trends and forecast possibilities.

2. Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students:

a. interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.

b. communicate information and ideas effectively to multiple audiences using a variety of media and formats.

c. develop cultural understanding and global awareness by engaging with learners of other cultures.

d. contribute to project teams to produce original works or solve problems.

3. Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students:

a. plan strategies to guide inquiry.

b. locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.

c. evaluate and select information sources and digital tools based on the appropriateness to specific tasks.

d. process data and report results.

4. Critical Thinking, Problem Solving, and Decision Making

Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students:

a. identify and define authentic problems and significant questions for investigation.

b. plan and manage activities to develop a solution or complete a project.

c. collect and analyze data to identify solutions and/or make informed decisions.

d. use multiple processes and diverse perspectives to explore alternative solutions. (ISTE, 2007)

The combined ISTE NETS for Students, Teachers, and Administrators form the basis for an internationally supported set of best practices for the use of educational technology and provide important measures for evaluating web-based educational resources such as the proposed D2D website.

Moore and Huber (2001) showed that Internet technologies could not only support the goals of EE but could also extend and deepen their learning by providing opportunities to engage in authentic scientific discourse in ways that might not be possible without the use of the internet (pg. 23). Students were exposed to scientific discourse in a way that enhanced their view of themselves as participating community members and promoted the practice of environmentally sound behaviors (Moore & Huber, 2001, pg. 24). However, some research contradicts the findings of Moore and Huber. Wright (2008) found that environmental literacy scores for students engaged in online classes were significantly lower than their counterparts who participated in brick and mortar classroom classes. Online students were less likely to be emotionally engaged in the topic and showed lower scores in the areas of knowledge and environmentally friendly opinions (Wright, 2008). The questions raised by Wright and others suggest that technology alone is not sufficient to engage students in authentic learning and critical thinking; proper scaffolding of the web-based activities is essential (Wright, 2008; Engstrom & Jewett, 2005; Montelongo & Herter, 2010; Moore & Huber, 2001).

Citizen Science

Citizen science (CS) describes the partnership between volunteers and professional scientists to answer real-world questions through research studies and data collection (Cohn, 2008). Although the term "citizen science" may be relatively new, citizen scientists have been

around for centuries (Silvertown, 2009). Prior to the late 1800's, science as a paid profession was rare and many of our most famous scientists, including Benjamin Franklin and Charles Darwin, made their living through another profession (Silvertown, 2009). A major hallmark of modern CS projects is the potential availability of the activity to all citizens, not just the privileged few with time and money to pursue their scientific interests on the side (Silvertown, 2009).

Many of these current CS programs collect data from a large geographic area and are designed to monitor broad-scale and long term environmental phenomena such as changes in animal populations and the spread of diseases, water quality, and global climate trends (Krasny & Bonney, 2005). Such large scale monitoring and data reporting by citizen scientists would not be possible without the existence of easily available technical tools, such as the internet and smart phones, for distributing project information and protocols and for collecting data from the public (Silvertown, 2009). Web-based tools also provide a means for providing feedback to project participants and answering their questions.

Silvertown (2009) contends that the "best way for the public to understand and appreciate science is to participate in it" (pg. 469). Krasny and Bonney (2005) assert that CS projects are not only important due to the scientific data gathered by participants but also as a means to educate the public about biology, ecology, and the scientific process. This perspective of CS projects supports the four of the five objectives of EE by increasing a participants' knowledge about their local ecosystem, their awareness of issues that may impact their local ecosystem and the phenomena they are collecting data about, honing their critical thinking and research skills,

and providing opportunities to become an active participant scientific research and environmental policy (Brossard et al., 2005; Krasny & Bonney, 2005; Silverton, 2009).

There is conflicting research regarding the impact that CS projects have on participants' attitudes and understandings. Krasny and Bonney (2005) discuss conflicting results from three different CS projects administered by the Cornell Lab of Ornithology which showed participants in Classroom FeederWatch and the Seed Preference Test experienced increases in their perceptions of themselves as real scientists and thinking about biology and the scientific process. However, pre-and post-tests of participants in The Birdhouse Network showed that, even though they showed increased knowledge regarding the biology and habitat of cavity-nesting birds, their overall attitudes towards the science and the environment and understanding of the scientific process did not change (Krasny & Bonney, 2005). In a formal study of attitudes of participants in the Cornell Lab of Ornithology's CS project, The Birdhouse Network, Brossard et al. (2005) found that while participants demonstrated a significant change in their knowledge of bird biology and reported increased understanding of the scientific process, they could not demonstrate the increased understanding of the scientific process and their attitudes regarding the environment and science did not change. The lack of significant impact on CS participants' attitudes towards science and the environment may be due to the complexity of their attitudes towards the subjects and the self-selecting nature of CS projects (Bossard et al., 2005; Krasny & Bonney, 2005).

Science Inquiry

One goal for many CS programs is the evolution of CS project participants from simply collecting data to being true citizen scientists through the process of learning to ask and

answer their own questions and engage in authentic science inquiry (Krasny & Bonney, 2005). Scientific inquiry is a process that leads the researcher towards answers to questions about the world around them through personal investigation and provides the researcher with reasoned, evidence-based answers to those questions (Lorek Strauss, 2011). The *National Science Education Standards* (Olson & Loucks-Horsley, 2000) refer to scientific inquiry as:

> The diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world. (p. 23)

Therefore, inquiry is not only a step-wise method for answering scientific questions but a learner-driven process that actively engages the learner in the research and feeds their natural sense of wonder and curiosity (Lorek Strauss, 2011).

This definition of inquiry is supported by the work of John Dewey (1910, 1938) who felt that problems encountered through experience provided a stimulus to learning by arousing the learners' natural desire to restore order and resolve uncertainty. This desire drives the learner to actively pursue the information necessary to answer the question or problem and through that process they construct new knowledge (Dewey, 1910, 1938). Dewey's work on Experiential Learning laid the foundation for the more contemporary educational theories that form the basis for the constructivist approach to learning theory. In the constructivist approach to learning, the individual actively creates knowledge and meaning by exploring and engaging in the world around them (Lee, 2011).

Inquiry-guided learning promotes desirable educational outcomes such as critical thinking, problem solving, self-direction and responsibility for learning and a desire for lifelong learning (Lee, 2011). Lee (2011) contends that inquiry-based learning helps individuals develop capacities and abilities that are relevant to work, home and community which include the "ability to communicate effectively; to interact with others, even those who are very different from themselves; to plan and manage complex projects; to take initiative; and to persevere in the face of obstacles and resistance" (p. 152).

The extent to which inquiry-guided learning is implemented is most often mitigated by the individual instructor, their assumptions about teaching and learning and their opinions regarding the use of inquiry as a valid teaching method (Lee, 2011). It may proceed gradually, at varying rates based on the individual teacher's current conception of teaching and learning (Lee, 2011). In the Driven to Discover (D2D) model of authentic inquiry through citizen science, the instructors are the scientist-mentors and both the adult leaders and youth participants fill the role of student. The adult leaders are learning how to facilitate inquiry in their youth participants and youth participants are students in the science inquiry process itself. The D2D model takes a developmental approach to the inquiry process by initially providing extensive support and scaffolding for the adult leaders and youth during the first phase of the project and gradually withdrawing support in subsequent phases as the abilities of the leaders and youth participants to partake in authentic inquiry increases (Lee, 2011; Oberhauser et al, n.d.).

Figure 1 - The Process of Inquiry; adapted from Lorek Strauss (2011, pg. 3, Fig. 1)

Needs Assessment

An important part of fulfilling the National Science Foundation grant that D2D was awarded includes demonstrating project deliverables. Stated project deliverables of the D2D project include:

1. Independent Research,

2. Dissemination

    a. training materials

b. WWW interface

c. training workshops

3. Annual Conference (Oberhauser *et. al*, n.d., pg. 6)

The results of this research project focus on and inform project deliverable 2 – project dissemination and specifically the creation of a WWW interface.

The WWW interface (website) will serve three primary purposes: it will become the primary mode of project dissemination; it will promote training and provide access to static resources; and it will enable the interchange of ideas between scientists, adult leaders and youth (N. Meyer, personal communication, October 19, 2011). The exchange of ideas and communication between scientists, adult leaders, and youth supported by the website should include facilitation of youth inquiry through citizen science, peer-to-peer networking between adult leaders and support for the transition from physical research teams with a face-to-face relationship with scientists to physical research teams with a virtual scientist (N. Meyer, personal communication, October 19, 2011). Data from the previous years focus groups show that adult leaders are disinclined to use the web-based tools associated with D2D, both for personal networking purposes (eg. Ning site) and with students (eg. VoiceThread, Animoto, blogs) (N. Meyer, personal communication, October 19, 2011). Therefore, a needs assessment is necessary to help inform and align the creation of the WWW interface with the reactions, perceived barriers and needs of adult leaders.

There has been debate within the education community regarding the definition, purpose, validity and methods of the needs assessment (Grant, 2002). Cook (1989) defined a need as "the

gap between an individual's desired and actual situation" and further stated that "a program will eventually fail or succeed depending on how well they address those needs" (pg. 462). Researchers have further clarified the definition of 'needs' to include "felt needs (what people say they need), expressed needs (expressed in action), normative needs (defined by experts) and comparative needs (based on group comparison)" (Grant, 2002, pg. 157). Rossi and Freeman (1993) describe a needs assessment as the "systematic appraisal of the type, depth, and scope of a problem" (pg. 56).

Needs assessments may be undertaken for many reasons and there are many models that can be adapted to different types of institutions or desired outcomes; therefore it is important to define the purpose and desired outcomes of the needs assessment (Borich, 1980; Grant, 2002). The purpose of this needs assessment was to determine the perceived needs and barriers that potential adult leaders express regarding the creation of a website to support inquiry in youth. The desired outcomes of this needs assessment included a discussion of expressed needs and barriers of potential D2D adult leaders regarding the website and specific recommendations to D2D project staff regarding web design characteristics which help address those needs.

Despite the flexibility of the model, needs assessments are bound by the general parameters of:

1) determining the study targets, or stakeholders, which includes those that are most likely to be the subjects or beneficiaries of the study;
2) specifying methods of contacting the target, common methods used in needs assessment are key informant, community forum, and survey sampling;

3) developing a unit of measurement, which allows participants to not only identify 'needs' but also to place them in a hierarchical order; and
4) interpreting the data to decision makers and stakeholders, without which the data will not be useful to the program stakeholders or administrators (Cook, 1989).

Borich (1980) states that the "versatility of these data makes the needs assessment approach less restrictive and more developmental than other training evaluation approaches" (pg. 42). Grant (2002) suggests that professional development research supports the idea that "learning is more likely to lead to change in practice when needs assessment has been conducted, the education is linked to practice, personal incentive drives the educational effort, and there is some reinforcement of the learning" (pg. 156).

Despite the broad application of the needs assessment model in program evaluation, potential limitations to the model exist. The needs assessment model relies on self-reporting and operates under the assumption that the subject can best describe his or her own needs and is capable of making objective judgments about those needs if specifically asked to do so (Borich, 1980). Grant (2002) also cautions that variety and flexibility in models should be embraced to help broaden the range of needs the formal needs assessment can identify and to help ensure that certain needs are not overlooked. A combination of formal and informal methods for assessing needs, such as questionnaires and structured interviews, may form the basis for an effective assessment, provided there is clarity of purpose (Grant, 2002).

With clearly defined purpose and goals, a needs assessment can provide a clearer picture of what can and can not be developed based on the needs of the intended targets and help guide

decision makers towards efficient and effective program development and use of resources (Boyd, 1992; Cook 1989).

Chapter 3: Methods

Introduction

The purpose of this study was to conduct a needs assessment which identified characteristics for the creation of a website that would motivate and enable adult leaders (licensed teachers, youth leaders and ISE educators) to use web-based technology to support youth in the authentic science inquiry process through the Driven to Discover (D2D) program. The needs assessment sought to provide answers to the research questions:

1. How do adult leaders describe the potential for using web-based technology as a means to achieve the scientist contribution to youth-based authentic science inquiry?
2. How do adult leaders perceive plans to develop a website to facilitate the ongoing relationship of scientists, adult leaders, and youth? What do they perceive as needs and barriers for using this planned website? What website characteristics would encourage them to use this planned website?

Research Perspective

Qualitative design and aspects of the constructivist and pragmatic worldviews shaped this research study. Creswell (2009) defined worldview as "a basic set of beliefs that guide actions" (p. 6). Worldview can also be described as the lens through which a researcher views the world and their research topic. Past research experiences, the discipline area from which the student comes, and the beliefs of the advisors and faculty in that area all combine to form the basis for the worldview that a researcher holds (Creswell, 2009).

The constructivist approach to research assumes that individuals create their own meanings and understandings of their world through their experiences and interactions with others in daily life. Therefore, each research participant will have a different view of the situation being studied and this can offer the researcher rich and varied perspectives on the research problem (Creswell, 2009). Researchers with the constructivist worldview also understand that their own perceptions and interpretations of the research are shaped by their personal, cultural, and historical experiences (Creswell, 2009). Creswell (2009) also identifies four general characteristics of the constructivist worldview, which are that

- individuals seek to create *understandings* about the world around them;
- participants create *multiple, subjective meanings* about their experiences,
- which are *socially and historically constructed*; and
- the researcher seeks to *generate or develop theories or meanings* rather than starting with a theory and conducting research that supports that theory.

The pragmatic worldview is primarily concerned with the applications of research for understanding and solving problems and acknowledges that research occurs in and is impacted by outside considerations, such as social, historical, and political contexts (Creswell, 2009). Pragmatism is historically derived from the work of American philosophers, sociologists, and educators Charles S. Peirce, William James, John Dewey, and George H. Mead and centers on the philosophical tradition of linking practice and theory (Creswell, 2009; "Pragmatism," 2011). Pragmatism offers a circular and mutable process by which theory is extracted from research and practice and the resulting theory is applied back to practice ("Pragmatism," 2011). Pragmatic researchers use all approaches available to seek solutions to a research problem and may employ

multiple methods to understand the problem (Creswell, 2009). Creswell (2009) describes the characteristics of research informed by the pragmatic worldview as being

- *problem centered*;
- arising out of *actions*, situations, and *consequences*;
- employing *pluralistic* methods to address problems which are
- grounded in *real-world practice*.

Research Design

Design Method & Strategy

The design method employed by this study was qualitative and descriptive in nature and employed an interview strategy to carry out a needs assessment for the creation of a web-based interface for D2D program participants.

Qualitiative Design Characteristics Relative to this Research Proposal

The characteristics of qualitative design, as presented by Creswell (2009), that were employed by this researcher included:

- Natural Setting – the up close information gathered by talking directly to participants and observing their behavior within a familiar context; this was accomplished through interviews in-person at a location of the interviewees choosing.
- Researcher as Key Instrument – data were collected by personal examination of documents and interviews with participants using interview protocol developed by the researcher and advisory committee.

- Participants Meaning – throughout the research process a consistent focus was maintained on discovering participants views and perceived needs regarding the development of the D2D website.
- Emergent design – interview questions, data collection methods, and individual research participants remained fluid in order to support the focus on gathering participant feedback on website design.

Researcher's Role

My interest as a researcher in the D2D project and the research questions in particular has been shaped by my experiences as a graduate research assistant for the D2D evaluation team, a personal interest in interactive, web-based learning, and through my professional experiences with citizen science.

As a research assistant for the D2D evaluation team, I have been present during participant focus groups for two years. The responses of focus group participants regarding the role that professional scientists play in the research teams, their opinions about the curriculum, and concerns that the adult leaders have toward the future role of scientists within the teams has increased my interest in discovering their perceptions towards a web-based platform for D2D interactions.

My professional experiences with citizen science programs have instilled a belief in the importance of citizen science to the field of science in general and as a means to increase citizen knowledge and investment in their local environments. My role as both an adult leader of a D2D research team and research assistant for the project has given me insight into the importance that scientists play in the process of developing authentic inquiry by youth through citizen science. It

has also allowed me to view the D2D research process as it currently exists and envision how the process might look in future phases.

Bounds of Study

Setting

This study was conducted within the University of Minnesota Extension Driven to Discover: Authentic Inquiry through Citizen Science project. D2D is a National Science Foundation funded research project that encourages youth to ask scientific questions, design and conduct their own research projects, and improve their understanding of inquiry through participation in citizen science.

Actors

Participants in this study included potential adult leaders of D2D research teams throughout the state of Minnesota. Adult leaders included licensed teachers and informal science educators. Youth development leaders such as 4-H and Girl Scout troop leaders also fell into the category of potential adult leaders but were not included in the sample due to scheduling conflicts. Selection criteria limited potential participants to individuals who have an interest in exploring online applications and are currently or have in the past worked with youth in science and environmental contexts. The researcher strove to interview equal numbers of participants from across three general categories of licensed teachers, informal science educators, and youth development leaders. Actual participants included three licensed teachers and six informal science educators.

Events

Using interview and needs assessment research methodology, the focus of this study was the perceived needs and barriers of the adult leaders towards the creation and use of a web-based interface for interaction with professional scientists and facilitation of authentic inquiry by youth participating in the D2D project.

Processes

Particular attention was paid to participant responses in relation to their perceptions towards online resources for providing technical support, advancing inquiry, addressing issues of methodology, facilitating interaction with scientists, and supporting peer-to-peer networking opportunities.

Ethical Considerations

The utmost consideration was given to protecting participants' rights to privacy and protection from harm by this research. As consistent with the methods already in use by the D2D project, the following steps were taken to protect participants' rights:

1. research objectives were explained verbally and in writing to ensure understanding by the participants,
2. verbal understanding and agreement to participate in the study was obtained from the potential subjects, including the participants' right to drop out of the study at any time,
3. a research exemption form was filed with the University of Minnesota Institutional Review Board (Appendix D),
4. participants were informed of all data collection devices and activities,

5. transcriptions and written interpretations of interviews were made available to participants,
6. confidential ID codes were generated for all participants and pseudonyms were used to protect participants' identities when reporting research results.

Data Collection and Recording Procedures

Purposeful Selection

Purposeful and directed selection was employed to select participants in the research study in order to collect data that would best answer the stated research questions and provide recommendations for creation of a WWW interface. Chain referral sampling was used to select potential participants. Chain referral sampling relies on a series of participant referrals to others who have experienced the phenomenon of interest; which for this research was accomplished by consulting an initial 'expert' who had an extensive network of relationships within each category of potential participants (Penrod et al., 2003). This allowed the researcher to access multiple networks in order to expand the scope of investigation beyond one social network (Penrod et al., 2003). Through this method, the chains of referrals were established and meshed together to form a sample that more closely resembled a representative sample of the study group (Kalton, 1993).

Data Collection Method

The primary method of data collection for this research study was interviews, conducted in-person. An initial contact email (Appendix A) was sent to participants and if the potential interviewee met initial selection criteria and provided verbal consent to participate in the study,

the researcher set up an interview time to meet in person. Participants were sent a confirmation email that included the interview consent form (Appendix B) and a link to a short video presentation created by University of Minnesota Extension that provided an overview of the D2D project and the objectives for the proposed website and asked to watch it prior to the interview date.

Strengths and Weaknesses

According to Creswell (2009), strengths of the interview method of data collection include the ability of the researcher to direct the line of questioning, an alternative to collecting data when direct observation is not feasible, and the ability of the participant to provide personal insight and perspectives on the research questions. Limitations of the interview method may include biased responses due to the presence of the researcher while collecting data, bias due to the personal perceptions of the interview participants, varying degrees to which participants may be able to articulate their needs and perceptions, and data collection outside the natural field setting (Creswell, 2009).

Interview Protocol

The researcher, under the guidance of the advisory panel and based on recommendations from Creswell (2009) and Mack et al. (2005), developed an interview protocol and set of questions and prompts that guided the interviews (Appendix C). Potential participants were identified by the researcher with assistance from 'experts' using chain referral sampling and personally contacted by the researcher with an invitation to participate in the research. Upon initial agreement to participate, interviewees were sent a personalized email explaining interview

procedures that included a link to a short video overview of the D2D project and consent information (see Appendix B) (Creswell, 2009; Hadiaris, 2009). Once participant consent was received, interviews/focus groups were scheduled at a location of the participants choosing. In-person interviews were recorded using an audio recording device and a digital camera or screen-shots to document participants' examples of desired web characteristics. In order to facilitate collection of information regarding the way participants currently use the web and to identify desirable characteristics for web design, the attempt was made to schedule interviews in a setting that allowed participants' access to the Internet and a computer or other method of utilizing the worldwide web. When it was not possible to conduct interviews in a location with access to a computer or the internet, participants were encouraged to email the researcher links to web sites they may have mentioned during the interview.

Data Analysis

The purpose of interviews was to gather information regarding the perceptions and needs of participants regarding the creation of an interactive website. Participant response data were coded through an inductive approach for qualitative data analysis, which is a systematic procedure in which the analysis is likely to be guided, by specific objectives or research questions (Thomas, 2006). Thomas (2006) describes the primary purpose of inductive analysis as allowing "research findings to emerge from the frequent, dominant, or significant themes inherent in raw data, without the restraints imposed by structured methodologies" (pg. 238). Throughout, the terms 'categories' and 'themes' are used interchangeably; 'code' refers to the alphanumeric shorthand used to describe the themes or categories. Interview data analysis was

conducted as suggested by Creswell (2009, pg. 185), Thomas (2006), Elo & Kyngäs (2007), and Hadiaris (2009, pg. 32):

1. *Organize and prepare data for analysis.* In this step, the researcher transcribed the recorded interviews, typed up notes from the interview, and organized the visual data from screenshots and photographs.
2. *Read through all the data.* The researcher read through each interview transcription and associated notes and visuals and noted general ideas and impressions for each participant's responses.
3. *Begin detailed analysis with a coding process.* Researcher organized the data into meaningful segments, developed a list of significant topic areas or themes, and labeled data with a word or short phrase that corresponded to the codes and summarized what the data was about. The code and theme key (see Appendix E) that resulted from the close reading of the data in step 2 had four key features: category labels, category description, example text or data associated with the category, and links between categories (Thomas, 2006).

After the first code and theme key was generated, the researcher re-read all the data and labeled data segments based on the key. The process of revising the code/theme key and re-coding data was repeated three times to refine the categories and to reduce overlap or redundancy or expand on emerging themes (see Figure 1 for general overview of the coding process).

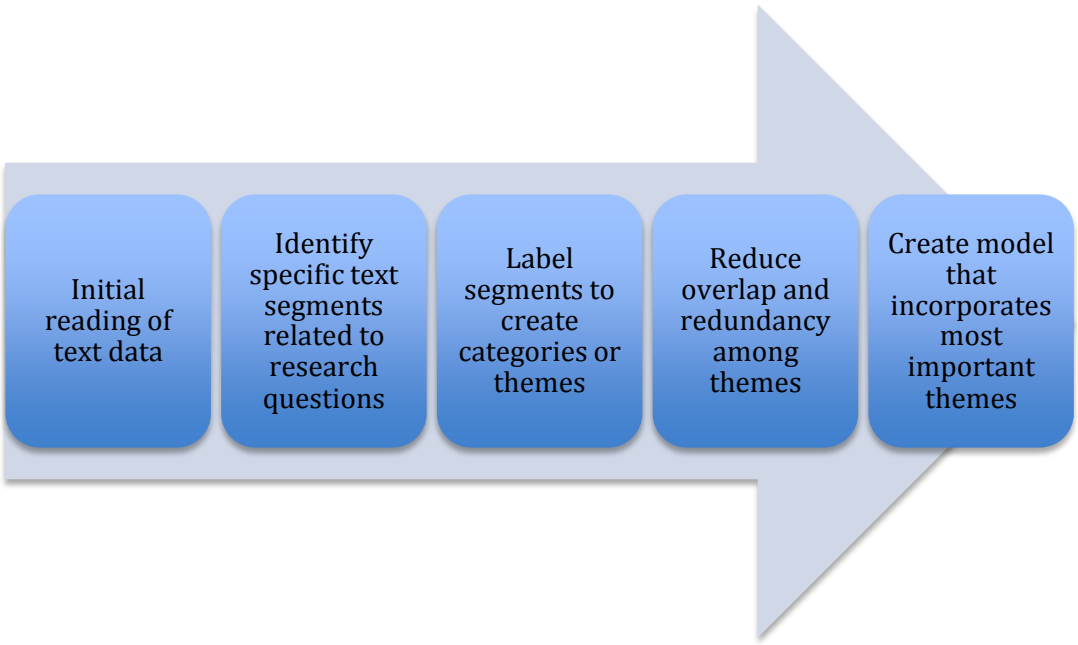

Figure 2 - The Coding Process in Inductive Analysis; adapted from Thomas (2006, p. 242, Table 2).

4. *Advance how the description and themes will be represented in the qualitative narrative.* Data analysis and results are presented in a narrative format based on the order of the interview questions rather than the order of research questions. This is representative of the flow of the interview conversation from the general to the specific.
5. *Interpret the data.* After data analysis, alignment to the research questions was examined and recommendations for the development of the WWW interface were proposed.

Reliability and Validity Measures

Reliability

Reliability of the data was checked by inspecting interview transcriptions for mistakes, comparing data with codes throughout the data analysis process and comparing codes with

established definitions to inhibit code drift, and cross-checking of codes by advisory committee members to ensure clarity of code definitions (Creswell, 2009).

Validity

Validity of the data was assessed in multiple ways. Participants were provided an opportunity to clarify their statements and comment on research findings. "Thick" project descriptions were used to provide a context for results. In addition, negative or discrepant data was presented as part of the results and an advisory committee was used for peer debriefing and review (Creswell, 2009).

Chapter 4: Results

Introduction

Data collected for this study were analyzed in order to identify characteristics which would inform the creation of a website for the Driven to Discover (D2D) program. The objective of the proposed website is to motivate and enable adult leaders (licensed teachers, youth leaders and ISE educators) to use web-based technology to support youth in the authentic science inquiry process. Interview protocols aimed to provide answers to the primary research questions:

1. How do adult leaders describe the potential for using web-based technology as a means to achieve the scientist contribution to youth-based authentic science inquiry?
2. How do adult leaders perceive plans to develop a website to facilitate the ongoing relationship of scientists, adult leaders, and youth? What do they perceive as needs and barriers for using this planned website? What website characteristics would encourage them to use this planned website?

Secondary research questions that emerged from the interview process included:

3. What resources are adult leaders currently using to support inquiry? Are they web-based or hard copy?
4. How are adult leaders currently using the web?
5. What do adult leaders perceive as their strengths and weaknesses in the inquiry process and how might web-based technology supplement those areas?

The results of this research are presented according to the themes and sub-themes as they emerged from the interview protocol (see Appendices C and E) during the transcription and data coding process. It is important to note that some quotes were coded into multiple categories if

they included insights regarding multiple themes and help shed light on the connections that participants were making among themes.

Participant Demographics

Research participants fell into two general categories: licensed teachers and informal science educators (ISE). The researcher interviewed three licensed teachers and six ISE from the greater Duluth area.

Licensed teachers included two practicing teachers and one retired teacher. Of the two practicing teachers, one taught middle school Life Science at a private middle/high school and the other taught second grade at a public elementary school and served as coordinator of the School Forest. The third teacher was recently retired from a public elementary school.

All six ISE educators that were interviewed had a current and/or prior affiliation with the University of Minnesota Duluth; four were current Masters of Education candidates in the Environmental Education program, one was a graduate of the M. Ed program in Environmental Education, and both non-graduate students worked for organizations where the University of Minnesota Duluth is a primary funder or cooperator.

Participants were given pseudonyms for the purposes of reporting research results. See Appendix F for a table of participant demographics and quotes attributed to each.

Emergent Codes and Themes

Primary themes used for coding were drawn from the interview questions (Appendix C) and sub-themes emerged during the transcription and coding process as categories that further described and organized participants' comments within primary themes.

Current Resources Used for Inquiry

The primary theme of *current resources used for inquiry* was used to code participant responses regarding resources and methodologies that they are currently using to work with

youth around inquiry and is divided into the sub-themes of *web resources* and *hard copy resources*.

Web Resources

The sub-theme of *web resources* was defined as "resources or tools that are web-based." Seventeen quotes by seven different participants (two licensed teachers and five ISE) were coded in this category. Examples of quotes that fall into this category are listed below.

> "I just came across, was it, Ruby Web, I think it is or something along those lines. It's a rubric website where you can create, maintain, search, um, different ways to assess student performance. And so, say we're trying to get at some, you know some topic. And being able to go there and say, a student that is good at understanding this topic will meet these criteria. And um, so you could use that, you wouldn't have to necessarily use that to assess the student, but you could then assess your program. Like is my, is this inquiry program doing X, Y, or Z, um that's what I could imagine I could use it for, if I wanted to." – ISE 3, Q21

> "Right now my dream project is to incorporate Great Lakes literacy into our current curriculum. And so the principal at Lester Park, what I taught last year, where I retired from, is allowing me to use all six levels, and I'm starting with the 3rd grade to make that effort to incorporate something particularly with Superior but with all of the Great Lakes, any of the Great Lakes...part of what I do…I'm using the Minnesota State Department of Education resource referred to as Frameworks and STEM...Oh my gosh, it is chock full of fabulous, fabulous things. And it's, the only thing that I've tapped into is the science and math and the technology part of it is the fact that they provide websites. And so that's where I have gone for a huge number of places. I love that whole Frameworks, it's really a super place." – LT3, Q39

> "I just recently came across two websites, and I'll have to send them to you, but it's like it's designed for elementary through, elementary, middle, and high school science educators but it's like 'what is science? what is inquiry? how do we develop this?' and it's easy access to terms and questions and methods and tools um. And then there was an Earth encyclopedia that was really cool that I like." – ISE4, Q52

Hard Copy Resources

The sub-theme of *hard copy resources* was defined as "resources that are not web-based." Two quotes by two participants (one licensed teacher and one ISE) were coded into this category. An example of quotes that fell into this category is listed below.

> "Otherwise, I am, after I pound in vocabulary through our science book, I pound the vocabulary into them and then I spend my time with Project Learning Tree and Project Wild and Project Wet." – LT2, Q97b

Current Web Use

The primary theme of *current web use* was used to code participant responses regarding their current use of the WWW and web-based tools and is divided into the sub-themes of *information, networking, pleasure/fun,* and *mapping*.

Information

The sub-theme of *information* was defined as " websites used for gathering information for teaching or for professional use." Nineteen quotes by eight different participants (two licensed teachers and six ISE) were coded into this category. Examples of quotes coded into this category are listed below.

> "Um, you know, other, I mean what I use personally - go on ERIC and go look up journal articles or things like that, when I think about my own kind of inquiry that I'm doing at my graduate level. But, as far as places where I would be you know, telling students to go, Wikipedia is most commonly used I think. But you know, you have to be really careful with, you know, what you're citing out of those things." – ISE3, Q22

> "I know D mentioned, in the past the [Minnesota] DNR website was not as functional as it could be but I think it has improved greatly. They have a lot of education pieces, whether it be on digital photography or the trail cams, um with a fair amount of resources. Web 2.0 things that can be very beneficial; maybe not the inquiry part but getting resources to start a project. Also SEEK Minnesota, I think is the website [ISE5]...there's a SEEK Wisconsin one too that I like; or EEK. E-E-K [ISE4]...well this is SEEK but based on environmental education. [ISE5]" – ISE4 & ISE5, Q82

> "I have all kinds of web pages, not a single science one anymore. Not a...no, I've used, but there's the weather calendar group, I've used the weather calendar stuff and I've used their web page and that's, that has been good...I don't, I use a lot of technology, I've got a SmartBoard and I've, for like, going to a website for resources I'm just, it hasn't worked, it hasn't fallen in. I haven't found anything workable." – LT2, Q99

Networking

The sub-theme of *networking* was defined as " websites used for social or professional networking." Five quotes by four different participants (one licensed teacher and three ISE) were coded into this category. Examples of quotes that were coded as *networking* are:

> "It's just funny to look [at my bookmarks] and it's Facebook, or The Weather Channel, or my bank." – ISE3, Q23
>
> "I use Facebook myself a lot. I use it for my School Forest. Um, an awful lot." – LT2, Q100
>
> "So because I'm like living in this world of distance learning right now that we're starting this, sort of project right now. This is the Center for Interactive Learning and Collaboration. One of the things that I think is unique about them is that they, they're about video conferencing connections - which could be a tool that you use but doesn't have to be but one of the things that they have on their website is a collaborations page. And so you can search ways that people have collaborated, students with each other or teachers with each other or students with an organization or they have all of these ways that people have used video conferencing to collaborate in the past. Or you can post to this and say I'm looking for a collaboration about, and I think that's a pretty awesome resource to have out there." – ISE2, Q114a

Pleasure/Fun

The sub-theme of *pleasure/fun* was defined as "websites used for pleasure or fun." One quote by an ISE was coded into this category. The quote that was coded into this category is:

> "But if I look at, so Geocaching.com. We could look at that. So there's applications here, you could do all kinds of scientific stuff, it's all location-based study. It's geography, it's technology use, you know, it's making a game out of using a GPS." – ISE3, Q25

Mapping

The sub-theme of *mapping* was defined as " web sites or tools used for mapping purposes." Two quotes by an ISE were coded into this category and are included below.

> "I haven't, I think Wisconsin has one that's called "NatureMapping". But it's not, it's kind of clumsy. I haven't used it a ton, but it's so easy with GoogleEarth now to put waypoints in and um, especially if you have some central person that's mapping the data as it comes in. They can export it very easily if they're using ArcMap, or KXM (??) file, they can go to anyone and GoogleEarth is free and it's, and there's soil data that's free, there's ownership data, for counties and stuff." – ISE1, Q1

> "I think, I, I'm really big into mapping. And so I use GoogleEarth a lot, with both adults and these high school students. And they, they just, the power of that is, connecting data to locations. And so you get your specific data [here/years??] but how does that fit into the landscape scale, how do you rise up and see that bigger picture? I think that's the huge, and how do you connect with other, you know, other schools doing similar projects, and let's, let's look at what they're doing...I think that mapping function is really key." – ISE1, Q6

Barriers to Using the Web for Inquiry

The primary theme of *barriers to using the web for inquiry* was used to code participant responses regarding their perceived barriers to using the web and web-based resources to support inquiry activities with youth and is divided into the sub-themes of *setting/web access, time, perceptions/have enough resources,* and *adult leader discomfort with technology*.

Setting/Web Access

The sub-theme of *setting/web access* was defined as "barriers to using the web for inquiry based on the setting where education is delivered; either due to non-sequential nature of contact or a lack of access to the internet." Two quotes from one ISE were coded into this category are:

> "It's a different perspective to think about, using this website and internet access and technology. I'm well educated, I've taken courses at graduate level how to teach with

> technology in the field but I feel like I have these barriers because of my agency and the lack of support from management or the lack of support from actual tools, um, that I'm unable to incorporate these things. And part of that is probably just being young in the field and not being able to establish myself at one center for a while. Um, but yeah, it's something that I don't often think of and like I said, my students very rarely interact with technology, websites, whatever, due to the time constraints." – ISE4, Q56

> "So I'm thinking about this question [referring to the role of web-based technology in inquiry] and wondering if it's, you know I think about methodology. Can I use this in, can I use this web in my methodology, the website to help further the lesson. And I think that that would be a barrier due to the nature of the facilities that I teach at; because we are, I'm an outdoor educator and the agency that I work for, we don't have computers, we don't have iPads, we don't have things to use in the field with the students or even when we come back in to use with the students." – ISE4, Q57

Time

The sub-theme of *time* was defined as "barriers to using the web for inquiry due to time restrictions." Five quotes by two participants (one licensed teacher and one ISE) fell into this category. Examples of quotes are:

> "The networking, I just don't know if people will take the time to do it. Um, I may be wrong but, it seems like, we had a Master Naturalist chapter for instance, and it kinda flopped. Because people are just not, it's not where they want to spend their time. They want to be out doing the stuff." – ISE1, Q9

> "Again, it would be neat but it would be so close to me work that you know, I probably wouldn't do it very much. I mean, I wouldn't, it would still be work...they have webpages that they beg us to use and they work their rear end's off and they're no help to me. They just, I can't get to it. And we've done it too. The School Forest [Minnesota DNR project] has a big webpage and we have our own special log in. And I know we were supposed to have this whole thing where everybody shares their lessons from across the whole state and 'oh I found this cool thing' and 'I found this cool thing' and I'm willing to bet that nobody uses it...And I know she tried so hard but it just..." – LT2, Q102

Perceptions/Have Enough Resources

The sub-theme of *perceptions/have enough resources* was defined as "barriers to using the web based on the educators' perception that they already had sufficient resources for inquiry." Five quotes by three participants (two licensed teacher and one ISE) were coded into this category. Examples of quotes coded as *perceptions/have enough resources* include:

> "We have an incredible array of science going on in this area. So for the kids to be able to see what they're doing is one thing...because first of all I would want teachers to be able to use that site and to share it with the students. So anything that's on there would be something that I would want the children to be able to use as well. So it really isn't, one is not going to be that much different from the other. When I think about children now, I'm thinking alone. That, what could they go to find at this website that they wouldn't have checked out during school. So there lies just a bit of a dilemma." – LT3, Q43

> "I mean, it would be, 'cause, you know, once I've taught a lesson once - I've gone through my information, I've studied something and okay here's what I want to do, when it comes back time to do it again, I'm probably not gonna go through that kind of work again. So I'm not gonna go back to a website, I'm not gonna go back to um, like my math book. When I went through it once last year, the teacher's manual, I don't go back to the teacher's manual anymore even." – LT2, Q108b

Adult Leader Discomfort with Technology

The sub-theme of *adult leader discomfort with technology* was defined as "barriers to using the web due to the adult leaders' unfamiliarity with web-based tools or bias against using web-based tools." Five quotes by four participants (two licensed teachers and two ISE) were coded into this category. Examples of quotes coded as *adult leader discomfort with technology* are:

> "I agree with what these two have said. The only piece that I would have to add goes to what S said about tools. And the tools that I think could be useful are the actual data collection tools, or how you get the data into a usable form. Which I think can be really intimidating for folks, especially if they're not strong with their math skills or things like

> that. And I see this as a use for students if you could, you know, if you had a tool that was really easy to use. But also the adult leaders, adults who don't feel comfortable with that. If there was a developed tool that they could use that was very user-friendly; instead of like Excel or something like that where you're just plugging, if you're just plugging numbers in to a program, so then if Excel is not user-friendly, then they have to accomplish learning how to use the program before they can even get to the data analysis." – ISE6, Q64
>
> "I would also say that having the adult supervisor or the science researcher being comfortable to use those web tools and actually promoting them is a huge thing. It shows the confidence of their ability to use technology, which is becoming more and more important for youth; but also that they actually use it in their daily lives and it's not just the kids saying 'well this is some dumb tool that they're making us use'. The researchers actually use them. So also finding out what scientists use in the field could be really beneficial." – ISE5, Q81
>
> "Also, some kind of YouTube how-to's. You know like there's um, I think the thing that makes inquiry science the most intimidating to me is that it often requires use of some kind of technology or some kind of tools that I may not have had access to before. Or that I haven't used since college. And, so it would be nice to see somebody kind of doing it right. You know, a clip of somebody working with kids using the technology, watching kids use the technology, um." – LT1, Q86

Inquiry Process Strengths

The primary theme of *inquiry process strengths* was used to code participant responses regarding their perceived strengths within the inquiry process and is divided into the sub-themes of *sparking interest, reflection, guided inquiry/observation, moving students to ask their own questions,* and *data collection/analysis.*

Sparking Interest

The sub-theme of *sparking interest* was defined as "self-perception of strength in getting students engaged in and excited about the inquiry process; including asking questions." Thirteen

quotes by eight participants (two licensed teachers and all six ISE) were coded into this category. Examples of quotes categorized as *sparking interest* include:

> "I think I'm good at sparking interest because that's what a lot of my programs consist of, because they are such a short time frame, and so it's really 'what is this? what can we explore? where can we go from here?'" – ISE4, Q61 (excerpt)
>
> "And so one of the things that I use to get them excited often is, if we're studying about insects then we'll watch some clips, like the ultra slow motion dragonfly taking off. You know, so cool. And so I guess I try to start with some kind of inspiration. Which is John Young, ah talks about mentoring kids and teaching you and how it starts with this inspirational piece. Because, um, you know unless kids are really excited about it, um you can either force kids to go do an insect study or you can have kids begging you to go to an insect study, and so an inspiration piece is important. And so I like to start with those kind of clips." – LT1, Q83b
>
> "I would agree with these two, that my strength would be in embracing the question or coming up with good questions and embracing the unknown. Just like the process that it's okay to not know the answers and that experience is actually a life-long process. Where you don't need to always know the answers, and even I, as the leader, continue to not know the answer to questions. And I embrace that and I will use the tools that I'm showing them to learn myself." – ISE6, Q59
>
> "But um, I would think so for me, one of my goals in teaching middle school has always been to really excite kids about science and get them involved and get them hands on." – LT1, Q84b

Reflection

The sub-theme *reflection* was defined as "self-perception of strength in engaging students in reflecting on the inquiry process or their experiences in nature." Two quotes by two participants (one licensed teacher and one ISE) were coded into this category and are included below.

> "Some of the strategies we used to kind of inspire that wonder and work on reflection was journaling. And that varied a lot on the participants because some were there for a

> half day, some where there for a full day, we did journaling, reflection, sketching, things of that nature." – ISE4, Q78
>
> "So I was really big into observation, and journaling, and writing and I guess that's my language arts background, and then correlating that into science." – LT2, Q103 (excerpt)

Guided inquiry/observation

The sub-theme *guided inquiry/observation* was defined as "self-perception of strength in moving students through all or part of the inquiry process using predetermined question(s)." Five quotes from two participants (both ISE) were coded into this category. Examples of quotes coded as *guided inquiry/observation* included:

> "I feel I'm weakest at, kind of um, inspiring that, I can do, I can do a set project very well. Um, but I'm less, um, talented at that kinda, open ended realm. Where you kinda open it up and then it diverges." – ISE1, Q5 (excerpt)
>
> "I think it's just being that guide. I mean you get students fired up about a topic and then you, they come to you with the questions. And then you, you guide that. Show them resources. You're, you're going right along with them." – ISE1, Q18 (excerpt)
>
> "I think that we do, like I had mentioned, the first part pretty well. And some pieces of some of these secondary pieces where we do frame it that, we do a lot more sort of guided inquiry and less like true inquiry I think; because we have a limited set of options, sort of roads for kids to travel down, just because those are the tools or those are the pieces that we have in place." – ISE2, Q122a

Moving Students to Ask Their Own Questions

The sub-theme *moving students to ask their own questions* was defined as "self-perception of strength in engaging students to devise their own authentic inquiry questions." Five quotes by four participants (all ISE) were coded into this category. Examples of quotes in this sub-theme included:

> "…But we did set up each lesson with inquiry in mind. We did the KWL model, "know, wonder, learn", and so we would start each lesson out with that. Whatever the students wondered about, what they had questions about, would kind of help guide how I would tailor the lesson to the age group and to the audience. So we had a set curricula, we talk about these key points but again, guided by the "wonder" questions." – ISE4, Q51 (excerpt)

> "I would agree with these two, that my strength would be in embracing the question or coming up with good questions and embracing the unknown. Just like the process that it's okay to not know the answers and that experience is actually a life-long process. Where you don't need to always know the answers, and even I, as the leader, continue to not know the answer to questions. And I embrace that and I will use the tools that I'm showing them to learn myself." – ISE6, Q59

> "I think if given, like as an individual, given that opportunity that suddenly I have a science club of kids that want to do this project, I feel like personally I would feel pretty comfortable helping them get through. But I think there's always things that I could learn about moderating that experience; just from a few workshops I've been to and sort of conference presentations about inquiry. I mean, I think there are a lot of tips and tricks out there for getting kids from point A to point B and beyond." – ISE2, Q121 (excerpt)

Data Collection/Analysis

The sub-theme *data collection/analysis* was defined as "self-perception of strength in guiding students through collecting and analyzing data; either to answer their own questions or as citizen science." One quote by an ISE was categorized into this theme:

> "I would say that I also am pretty comfortable at sparking interest and coming up with a testable question and even doing data analysis and looking at what the data could mean…" – ISE5, Q60 (excerpt)

Inquiry Process Weaknesses

The primary theme of *inquiry process weaknesses* was used to code participant responses regarding their perceived weaknesses within the inquiry process and is divided into the sub-

themes of *determining testable questions, moving students to ask their own questions, data collection/analysis, assessment of process, drawing conclusions/sharing or using data,* and *defining inquiry process/steps.*

Determining Testable Questions

The sub-theme *determining testable questions* was defined as "self-perception of being weak at guiding students through the process of determining which questions can be answered through research." Five quotes by two participants (one licensed teacher and one ISE) were categorized into this sub-theme. Examples of quotes from the sub-theme *determining testable questions* included:

> "…We never really did get good at research, myself. And getting those kids to ask those driving questions and then testing them, testable questions. And probably could have used a lot more help in getting kids to that point. And then, because I even had a friend...who would try and help me with that, but without the science background it was hard to do that." – LT2, Q103 (excerpt)

> "…the hardest one for me, I don't know if it was for others, was to actually come up with a testable question. And so what is a testable question, and what are some examples of a testable question, what, you know literally, what is it, what do they look like? Because I can get, if I knew, as teachers we know if I know that I want them to get to, I can get them there. I can get them to the testable, I can get them there. But what is it? Where are we going?" – LT2, Q104 (excerpt)

> "I mean I think that there are some pretty awesome examples of kids doing science...I think that there are lots of other ways that kids can have an experience in science that's meaningful to them. But that piece, that sort of navigating all of the possibilities to a few that are actually doable." – ISE2, Q123b

Moving Students to Ask Their Own Questions

The sub-theme of *moving students to ask their own questions* was defined as "self-perception of being weak at guiding students to ask their own questions; moving beyond guided

inquiry." Seven quotes from four participants (one licensed teacher and three ISE) were coded into this category. Examples included:

> "Places where I am best, when it comes to inquiry, is the exploration part of it. You know if students can come up with questions, I'm all about you know, figuring things out. Whether that's through play or organized classroom activities, um discussions, whatever it takes, whatever the students really direct; that's where my strength lies, is I can, I really enjoy and I feel like I'm very successful at those kinds of facilitating...to answer the questions more than coming up with the questions. Sure data analysis is part of that but you know it's, I feel less skilled at um, you know, creating the questions. Or you know, asking questions to get them to ask questions...and that's something that I work on, but that's where I've got an opportunity for growth." – ISE3, Q27

> "I think if given, like as an individual, given that opportunity that suddenly I have a science club of kids that want to do this project, I feel like personally I would feel pretty comfortable helping them get through. But I think there's always things that I could learn about moderating that experience; just from a few workshops I've been to and sort of conference presentations about inquiry. I mean, I think there are a lot of tips and tricks out there for getting kids from point A to point B and beyond. Even something like going from that collective brainstorm of questions and ideas to coaching without giving the answer, really, I think that that to me would be probably one of the more challenging steps; is having, helping kids make the decision, the decisions for how to answer their question. Knowing that some of those things aren't going to work out and that's part of the process and they have to try it and see." – ISE2, Q121

> "But I've seen a few folks speak that had great suggestions for how to narrow down from the, this like huge cacophony of ideas to things that were actually testable within the given time frame and with the resources they had and so that skill of being able to guide kids down a path where they're actually making the calls but from within a certain range of options. Like 'oh we don't have our own satellite, so how can we get that information? How, we don't have the huge piece of equipment that we need to analyze these samples so how, where do we go from there? Who do we reach out to?" – ISE2, Q123a

Data Collection/Analysis

The sub-theme *data collection/analysis* was defined as "self-perception of being weak at guiding students through the process of collecting data to test questions and then analyzing the

data that is collected." Five quotes by four participants (one licensed teacher and three ISE) were categorized by this theme. Examples of quotes coded as *data collection/analysis* included:

> "And then the, it is pretty intimidating to enter into, well to collect data for somebody else to me seems a little intimidating, because I'd want to do it right. And often, I don't beat kids up on data collection techniques, so like I just don't know what I'd do if we came back and a kid said 'I found...'. Like so here's an example, we were at Camp W last week and a kid told me that he saw a kingfisher, which it's, it, he didn't. I mean it would be very unlikely that that's what he saw, uh, and so we got the range maps out and we looked at it and the kid was still pretty sure that's what he saw, even though the range maps would indicate that they would not be here this time of year. And so I just let it go. But if we were actually submitting that data, I'd feel this added pressure of, um, I don't know, just an added pressure. Like what if kids are making mistakes, what if they are misidentifying things and yeah. So anyway that would be one of the pieces that I would feel like I would need some training on or some advice on." – LT1, Q85

> "Um, one of the things we try to do in supporting teachers is provide them with ideas and resources, even props or kits or tools that they might need to carry out some sort of additional inquiry. There's been a lot of interest around sort of stream monitoring or water quality because a lot of schools have a stream that goes through the property so how can we give teachers the resources, the background or the skills to actually implement something that's meaningful that maybe those kids can collect data that is reported to PCA as part of their greater monitoring. And so we try to create these bridges and try to connect teachers with projects that are already ongoing that they can just tap into, um, that is sort of hit or miss about that has gone over the years." – ISE2, Q120

Assessment of Process

The sub-theme *assessment of process* was defined as "self-perception of being weak at assessing the quality of learning achieved through inquiry." Two quotes by two licensed teachers, included below, were coded under this sub-theme.

> "I think that area which I would need most help personally would be in the assessment. I really like the process and I, actually I don't really care if the kids can pass a test on it. But if they had fun doing it and I feel that they were excited about it. I, I don't really care about the other, but I do value that in some areas. So it probably is something that I

should have been a little bit more attentive about that. But I don't know that I really wanted to spend that much time on it. So that would be one of my weak areas. In today's world though, where we have to document so much it's becoming more and more necessary to assess." – LT3, Q42

"And then for me, in the past, data hasn't always been the important part. Like, the actual, like how the experiment turns out isn't as important as the actual just being involved in it. Or like the content, like I'll teach kids all the different orders of insects and whether they remember Coleoptera next year at this time isn't as important to me as them being super excited about where they found beetles or ah knowing that there's this huge diversity of organisms that exist on our planet that they didn't realize before." – LT1, Q84c

Drawing Conclusions/Sharing or Using Data

The sub-theme *drawing conclusions/sharing or using data* was defined as "self-perception of being weak at understanding what the data could mean; determining next steps for what to do with the data; where does the data go once the students are 'done with it'." Three quotes by four ISE participants were coded by this sub-theme. Examples of quotes include:

"I would say that I also am pretty comfortable at sparking interest and coming up with a testable question and even doing data analysis and looking at what the data could mean, but what I, where I think I would need help on and where I could improve is what you're gonna do with that data then. So you have this data that could actually, I don't know, conclude something, but where are you gonna focus that on? And I would assume that would have more, a lot to do with the question, and maybe that where I think I'm good and I'm not actually meeting all the needs. But really what then, how are you going to use the data to come up with a conclusion or change something either about your program or about the environment that you were trying to test in the first place. [ISE5]...And/or make it applicable to the students' lives. You know that last connection of 'so you're here, so now what'. [ISE4]" – ISE5 & ISE4, Q60

"I again would say that the data analysis process would probably be a weak point but I agree with what S said about not knowing where to take it. Even if I were to do it correctly or in a good manner, not knowing where to take it or what the students could walk away with like, 'I've learned this'. Or especially getting them to understand that it's a small piece of the puzzle and that the scope of this project that they're involved with

> might not be able to allow for answers or conclusions to be drawn but they're helped in a, they've helped by putting one piece of the puzzle in." – ISE6, Q62

Defining Inquiry Process/Steps

The sub-theme of *defining inquiry process/steps* was defined as "self-perception of being weak at understanding what activities make up the inquiry process; how they fit together." One quote, included below, by a licensed teacher was coded into this sub-theme.

> "I feel like I could use a better definition of inquiry science. Like so that I, it's hard for me to even answer that question because I'm not sure I know all aspects of inquiry science." – LT1, Q84a

Design Features

The primary theme of *design features* was used to code participant responses regarding suggested features to be included in the design of the proposed website and is divided into the sub-themes of *search feature*, *video tutorials, Ask an Expert/scientist, lesson plans, networking, resource library, data collection/analysis tools, example projects, FAQ, photo gallery,* and *data sharing.*

Search Feature

The sub-theme of *search feature* was defined as "ability to search the webpage using a key word or phrase." Four quotes by four ISE participants were categorized by this sub-theme. Examples of quotes coded as *search feature* are:

> I want to highlight what S said that I think might have just got flown past, that the really easy search tool is like huge. And for, like you can kinda hit and miss with your website layout but if you nail your search tool, you know people are gonna be content because they're gonna be able to get to where they want to go. And, you know, I remember three or four years ago, the [Minnesota] DNR website, the search tool was terrible. And it's

> slightly gotten, it has gotten better. But a lot of people are drawn to that search tool immediately; they won't even spend the time exploring the website, they'll go right to the search tool. And I don't even know the science behind how you make that a good tool but [ISE6]...developing a systematic approach to it [ISE4]...right. Have Google do it. [ISE6]" – ISE6 & ISE4, Q70
>
> "One of the other, I think it should have some kind of search feature. I hate going to websites that don't and you end up having to navigate like crazy." – ISE2, Q127

Video Tutorials

The sub-theme of *video tutorials* was defined as "videos that are embedded in the site or can be downloaded; showing specific steps in a process; explaining a skill; or sharing information through a video." Nine quotes from three participants (one licensed teacher and two ISE) were coded as *video tutorials*. Examples of quotes in this category include:

> "I think that's another cool thing is videos; If you have any, like, say you do a training and there's particular sections that everybody is going to be doing it's really nice to have little videos, people love watching a video compared to pulling up a lesson plan. Um, so we did, like in ours we're measuring DBH [diameter at breast height] and they're really short videos but the teachers just ate that up." – ISE1, Q12
>
> "It might be kinda cool for the, the students too, another common question of our experts in the school forest too, is how did you get to where you were? Like what was the educational path, or um internships, and what does it actually take to get there and what can you expect when you do get there. So maybe even just a series of YouTube clips on your site of various careers that might be related to whatever topic you have and um, what their typical day looks like...and they're if they're super interested in what they're topic is and what, they could connect with them and they know that they're connected to the project already and would you know, it wouldn't be a blind request from, they're gonna know why they're contacting them." – ISE1, Q17
>
> "One of the things that I love and would love to see on your website is, even like YouTube clips; I'm a very visual learner and my students tend to be visual learners as well." – LT1, Q83a

Ask an Expert/Scientist

The sub-theme *Ask an Expert/scientist* was defined as "features that connect professional scientists to visitors and facilitate information exchange between the two; information about scientist background." Twelve quotes from six participants (two licensed teachers and four ISE) were coded into this sub-theme. Examples of quotes in the *Ask and Expert/scientist* sub-theme included:

> "Um, a chat room. Or even like a weekly chat with varying scientists, or you could...like a bulletin board, like a place where you could submit questions or you know, requests for a resource and a professional would be able to get back to you. Think about the 24hour service you can get on, you know, different websites. Like, 'I have a question about how to do this' and someone gets back to you. 'I need to find this car part', you know and that kind of a resource." – ISE3, Q30

> "I remember several years ago, when I first started working with SmartBoard, I wanted to do a virtual field trip through either NASA or the Smithsonian as it turns out. And I couldn't afford them, 'cause they were pretty pricey. But I ended up finding a place where I could go and ask questions of a person. So I'm actually emailing back & forth with this NASA guy. And, oh my gosh, that just served so many purposes and it just turned out I couldn't afford it. But what a treat that was to be able to, I mean, to talk to NASA. That was pretty top drawer as far as I was concerned." – LT3, Q47

> "You definitely would want to have scientists where you can, you know, contact them. The website should be a base of contact, and not just names but put their pictures up there so you remember, 'oh I remember working with that person' and the bio and making that part personal so that, that's in that connection to the instructor." – LT2, Q105

Lesson Plans

The sub-theme *lesson plans* was defined as "pre-written, complete curriculum involving inquiry." Five quotes by three participants (two licensed teachers and one ISE) were categorized into this sub-theme. Examples of quotes from the sub-theme *lesson plans* included:

"I think um, lesson plans is another thing. I mean if I'm going to be the facilitator or if I am working on this inquiry process teaching, you know things that will help get at the point we might be looking for. If it's curriculum based, if we're looking at standards…" – ISE3, Q37

"So what I would, what I would think would be super cool is if you had like this, I mean I love the features. And then you could just drill through; you click on that, that's a video, you click on that, that's a video, that's a video, and then you, know what I mean? And then you got the little link down here that's the pdf of whatever the lessons are. You know, you label them lesson 1, 2, 5, 7, whatever." – LT1, Q94b

"You know the other thing would be, as I think about lessons, it's probably set up this way already but I imagine something like, I don't know what it would look like but something that would be a, you know the lesson title, there'd be some kind of brief description, and then there'd be some kind of YouTube clip to it and there'd be the pdf's right there, you know the teacher pdf, there'd be the student pdf; really easy to print off, easily, easy to access. And it would be really cool if, yeah if they were just really easy to access. [see Fig. 3]. That would be wicked helpful, it would be so helpful, because then you don't have to find the three ring binder, you don't have to remember which page it was on, you can just remember, oh yeah at that training we did that really cool thing with...measuring mass of larva." – LT1, Q91

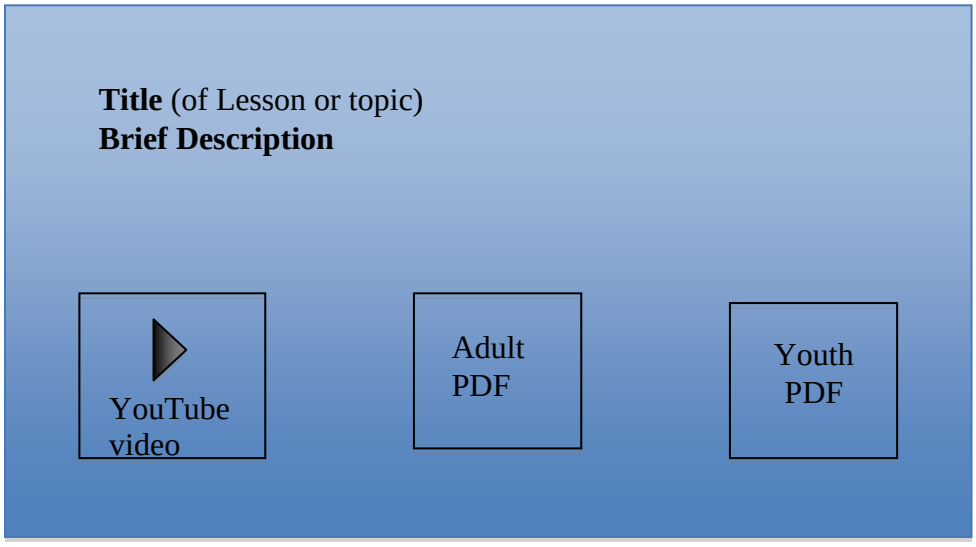

Figure 3 - Diagram of potential web site design; adapted from sketch by LT1, Q91.

Networking

The sub-theme of *networking* was defined as "features that connect people with each other." Fifteen quotes from six participants (three licensed teachers and three ISE) were coded in this category. Examples of quotes coded with *networking* included:

> "The networking, I just don't know if people will take the time to do it. Um, I may be wrong but, it seems like, we had a Master Naturalist chapter for instance, and it kinda flopped. Because people are just not, it's not where they want to spend their time. They want to be out doing the stuff." – ISE1, Q9

> "The social networking part just sounds, it might be good just to get people connected, that may not otherwise be connected. Like, you know, we have the Facebook model of 'I'm friends with friends with friends' and we found each other because of similar interest. That's helpful, but I mean so much of that networking is person to person already anyway that it just seems like a strange place to put energy. As far as you know, creating programming for citizen science, or creating programming for student inquiry and things like that. Although the social network part could be a component of it, but I don't know that it should be the focus; that was the one thing that I thought was really odd." – ISE3

> "It would be neat if, after you took a class and you did your training, um I know it talked about doing social networks and I'm not hugely into those but what I think would be really fun is, after you took the class there were some kind of, um, yeah some kind of online blog where you can just share what you've done and even share some of your questions…And the cool part is that, at least for me, after I've actually met people it makes it a lot more fun to share online because I know who is sharing what." – LT1, Q89 (excerpt)

> "Even something like a listserv that project leaders or whatever could be a part of; I'm part of a marine-educators listserv and so we see people throw these questions out there and then you have this huge wealth of experience that can shout about what they think or what their experience is. Having something like that, it sounds like social networking would be one way to do that too." – ISE2, Q132

Resource Library

The sub-theme *resource library* was defined as "information and resources available for use." Fourteen quotes by six participants (two licensed teachers and four ISE) were coded into this category. Examples of quotes from *resource library* included:

> "And then just a resource library for, you know, all of your materials will be there. But I think you first need the, I don't, I've found that it's really good to meet with your leaders, whoever they are, in person first. Go through, and go through the activities, the set ones at least, and then you point them to that resource. 'Cause they're not gonna just go there and learn it from the site themselves...But it's a back up that they can go to." – ISE1, Q7
>
> "You know, an indexed reference library. Everything from rubrics to lesson plans to um, publications; you know categorized in easy, easy to navigate kind of ways." – ISE3, Q31
>
> "I think also, different classroom resources. Things that, um, things that teachers could literally - make no doubt about it, a teacher loves a worksheet. It's safe, it's something we can take back to a super, a principal and say 'here we're doing something'. So different resources like that that can be printed out so the kids have a tool to work with. So um, reproducables, I know that people stick their nose up at it but they, that would get used all the time by every one if you had real reproducables that could be used in the field." – LT2
>
> "It feels like we get lots of requests for some of the content instruction. We've had a few adults contact us like, 'oh my kid has this project about whatever and we don't know anything about that, so help us'; if you were to look at content areas that you might be able to have some resources that are specific. So that as you're like building your project obviously you'd need to know some things about your topic in order to get there." – ISE2, Q129

Data Collection/Analysis Tools

The sub-theme *data collection/analysis tools* was defined as "tools or resources that will help make it easier for non-scientists to collect or analyze data." Eight quotes from four ISE participants were coded into this category. Examples of *data collection/analysis tools* included:

> "I agree with what these two have said. The only piece that I would have to add goes to what S said about tools. And the tools that I think could be useful are the actual data collection tools, or how you get the data into a usable form. Which I think can be really intimidating for folks, especially if they're not strong with their math skills or things like that. And I see this as a use for students if you could, you know, if you had a tool that was really easy to use. But also the adult leaders, adults who don't feel comfortable with that. If there was a developed tool that they could use that was very user-friendly; instead of like Excel or something like that where you're just plugging, if you're just plugging numbers in to a program, so then if Excel is not user-friendly, then they have to accomplish learning how to use the program before they can even get to the data analysis." – ISE6, Q64

> "But that knowing more about the ways, I think one of the things that is often a mystery to kids coming here, even adults, thinking about how science works, is how you actually, what's available for you to use as a tool to get the answer. Can you just make an observation with your own senses or do you need some added level of technology or I mean there are a lot of questions you can answer just using your own observation skills. *[134a]* But um, knowing kind of what that catalog of options is, I think is a, would be an interesting resource to have. To sort of think through, like how do you help kids understand which questions, when do you use a lab or when do you use the field or when do you have to use other tools or techniques?" *[134b]* – ISE2, Q134a/134b

Example projects

The sub-theme *example projects* was defined as "examples of previous inquiry projects." Six quotes by five participants (two licensed teachers and three ISE) were coded into by this sub-theme. Examples of quotes coded as *example projects* included:

> "As I said before, having a data analysis thing for adults would be really beneficial. And also a, a 'what are good examples of science inquiry?' 'What are past projects that have really worked?' *[66b]* For youth, having a lot of visuals [ISE5]...lots of visuals [ISE4]...visuals, audio, videos that can really say, these are the type of species - whether it be animal, plant, whatever, that I want to study. And going back to the butterflies, having projects that have already been used in the monarch or bird species within their local area. [ISE5] *[66c]*" – ISE5, Q66b & 66c; ISE4, Q66c

> "If you went the other way [referring to having students develop their own questions], I think something, a resource that does outline some of the, the ways people answer

> questions in science would be really helpful. Like these little toolkits of like here was a question and here's how it was answered using these tools. You know, whether you did like four or five different varieties to kind of help kids begin to think about designing the strategy to answer your question." – ISE2, Q137

FAQ

The sub-theme *FAQ* was defined as "frequently asked questions." Two quotes by two ISE participants were coded into this sub-theme. An example of quotes coded as *FAQ* included:

> "You know there's a really clear frequently asked questions part that's on there, that's, I think, no matter what site I've ever been to, that's been an example of really poor websites, or really good websites. That there's always going to be commonly asked questions and that can't just be some static page that is saying like, you know, 'How do I email someone?', like 'How do I...' like it needs to update. Because over time, you're gonna realize that, ooo, that's a really good question that we should pin on the front page so people can find it. You know, if everybody is asking 'Where can I find this resource' that should become, you know, something right on the frequently asked questions. I mean that's something that cognitively, like 'I have a question. Oh frequently asked. Maybe it's here' you know verses having to dig for it. Perform a search either on the site or Google, Yahoo, whatever...So it's not just a guess. Some of them are gonna be canned response, like 'what is your address', 'how do I find you', 'who do I contact for this' but then the bigger questions that are gonna start to be noticeable as regular questions. So someone should really by staying on top of updating that." – ISE3, Q35

Photo Gallery

The sub-theme *photo gallery* was defined as "library of photos that visitors are able to download and use free of copyright restrictions; photos that are relevant to the topics of learning." Five quotes by four participants (one licensed teacher and three ISE) were coded into this category. Examples of quotes coded as *photo gallery* included:

> "So, for me, I would need for like the larva project...but um I think the big key thing for me would be great pictures of larva and if there's diseases or whatever they're looking for, great images." – LT1, Q 87

> "If you're just going out and looking for bugs, that's so cool and kids should do it and you can just look at bugs. But if you're actually trying to figure something out, you gotta know what you need, and so I would say great images, great videos, and I would even say that they might be different videos for different parts of the state." – LT1, Q88b

> "If you're gonna have kids go through to that point of sort of reporting back on their data, something that we've been asked a lot for, as an aquarium from kids and adults, are photos. And so having a photo library with images that seem relevant; it kind of [unknown, grows?] even. I mean it could be those content areas, so like general pictures that might be useful for kids to use that they know they can use with permission, like without permission or even if as a place to, for them to upload their own images of what's going on. Something about pictures I think would be useful. And that's something that we've found to be one of the biggest challenges in our own work to is trying to source good photos that...even thinking about kids making a poster for some sort of a reporting session. They might have their own equipment to take those photos, but they might not. And so that's gonna be a barrier to them doing this project then maybe we can sort of help out." – ISE2, Q126

Data Sharing

The sub-theme *data sharing* was defined as "feature that allows users to upload their own data and share it with others." Twelve quotes by five participants (three licensed teachers and two ISE) were coded into this category. Examples of quotes coded as *data sharing* included:

> "If I were a citizen science group member working with children, I would need the directions, you know there would have to be someone there to teach me and the children about what we're doing and how this material is going to be used, the material that we collect. What other people have done, what other groups, where do we go, what site to use to find other data related to people doing the same thing. Not only in this country but maybe around the globe." – LT3, Q45

> "In that aspect, I think it could be really beneficial, and maybe not being able to or continue on with individual students but groups. Comparing data that you collected with

other groups that have come in the past; compare 'Today we saw 17 species of birds. Whereas a year ago we were seeing 20-30. What has changed?'" – ISE5, Q63

"And maybe part of it is, and having, and I think this is built in, but having a place to use their data once they've collected it. You know if they're, especially creating this video, you got me excited about that now. If only, and I wouldn't pick just the best ones but that there'd be some kind of criteria that if their video contained accurate information and that it was you know, well presented, that they'd actually get to put it up on VoiceThread or they'd get to put it someplace where people would see it." – LT1, Q93

"[Interviewer: If you were to say, Project Wet is gonna put a website together. What would you want it to offer you, that that book doesn't do?] Nothing. I mean the only place for that would be, and that's why I got excited for a bit with the phenology, because it was a place that the kids could go and insert their data. And that is, I could see a lot of use to that. A place where, any place a kid could come back and then insert their data. And use it in the, the web-based part as a kid's tool. A place to report, as a kids tool where they go through a scientific process or they could put their question in and, or even if the kids then could do more interacting with the scientist themselves. That'd help bring the scientist down to a little different level. Um, then I'd see it a lot more interactive." – LT2, Q108a

Design Characteristics

The primary theme of *design characteristics* was used to code participant responses regarding suggested distinguishing design attributes of the proposed website and is divided into the sub-themes of *simple, easy to navigate, light text, live/frequently updating/interactive, multiple faces,* and *visually appealing.*

Simple

The sub-theme *simple* was defined as "site is not cluttered, visitor is not overwhelmed by too much information or stimulus." Five quotes by four participants (one licensed teacher and three ISE) were coded into this category. Examples of quotes coded as *simple* include:

"Probably the simpler the better. Like some of these sites get so, there's a lot of great data but it's just too much..." – ISE1, Q14 (excerpt)

"I also like simple. Just that little clip that he showed of that website, it just looked so, my head was just kind of spinning. It just seemed like there were tons of tabs there were tons

> of, and I, maybe all that stuff is necessary. Um, and I guess you can't have it too simple either, but ah...I would love to get rid of all that [referring to the University of Minnesota, non-project specific tabs on the website] but that seems like you can't do that." – LT1, Q94a

Easy to Navigate

The sub-theme *easy to navigate* was defined as "visitors to the site can navigate without a lot of clicking of the mouse; visitors can move from page to page and retaining a sense of where they came from and how to get back to linked pages." Nine quotes by four participants (one licensed teacher and three ISE) were coded into this category. Examples of quotes coded as *easy to navigate* include:

> "…And then the tabs on the top, you know, you scroll over them and the drop downs appear. You don't have to click a lot, you can just kind of, your mouse just wanders and it'll expose new things. You know but then the headings on these are very well thought out. Like, what's under 'Learn' belongs under 'Learn', 'Your Profile' everything belongs under, it all makes sense where you're going…" - ISE3, Q34 (excerpt)

> "I think I like their website [referring to the Smithsonian National Zoo] as an example of a very clean, easy to use. Generally their stuff is pretty good." – ISE2, Q115a

Light Text

The sub-theme *light text* was defined as "site does not have very high density of text" and included one quote by an ISE. The quote coded as *light text* was:

> "I'm really all about clean design that uses lots of, like pictures or graphics instead of text. There are some websites that I have been to recently where it's just a pile of words and it's, for me that's really hard to sort of know where to go or what to do and I like the sort of 'choose your own adventure' type of like, being able to really find, like dig deep down into a website. You know there's theory out there about how many layers is too much for people to actually get to where they're going…" - ISE2, Q130 (excerpt)

Live/Frequently Updating/Interactive

The sub-theme *live/frequently updating/interactive* was defined as "aspects of the website are live or interactive; the site is maintained regularly; features are frequently updated." Eleven

quotes by five participants (two licensed teachers and three ISE) were coded into this category and examples of quotes include:

> "…So if you have someone that's devoted to ah, um, you know if you ask a question on this site you're gonna get an answer quick. It's not gonna be like a week, um, so I think that would be a crucial thing. If you're gonna be offering like, where people post, you should have someone devoted to getting back to them quick." – ISE1, Q10 (excerpt)

> "Well here's a dream, that they could be interactive. Yes. So if they're, let's say that you were the person in charge and so I emailed you okay I'm going to be a citizen science, scientist, group member, and I'm new to it and I google citizen science, you're something that comes up. And so, I would find your site and I would not only be able to investigate what's there but let's say that I'm looking for something and I can't find it anywhere, and I really have such a unique skill, let's say, my skill set is whatever, something that's very very unique but I know that it could be useful. How could I use your site if I couldn't talk to someone to say 'Well you might not have noticed in the River Watch, we could use someone with your skills.' That's just an example." – LT3, Q47

> "The [Smithsonian] National Zoo. One of the things that I think they do in a really unique way...they have a digital exploration part of their website. And they, where you can sort of tromp through the woods and then it's up to you to sort of pick things up and turn things over and then you can do like a little soil science activity." – ISE2, Q115a

Multiple Faces

The sub-theme *multiple faces* was defined as "site has one main homepage but separate sub-pages that include specific resources for specific user groups." Three quotes by two ISE participants were coded into this category. Quotes coded as *multiple faces* are listed below.

> "I think you could easily have, the quick thing is having two websites. Or I mean you show up at one but 'for adults', 'for youth'. Because it really, they really are, should be different focuses." – ISE5, Q66a

> "Is it a data collection or data analysis website; that would be a lot different than is it for the youth to look at and say 'Here are 15 species of birds' just looking at the pictures and they can click on and find all of this information, this is what I want to focus. Is it a tool

more for the youth or is it a tool for the adult supervisor who is helping guide them?" – ISE5, Q74

"It sounds like you might have multiple potential users for this site, that you might have those adult leaders, is the thought that kids might also be using the site? And so it might make sense that there are sort of different faces for each user. So maybe there's a general page but if somebody logs in, it kind of goes to what is actually relevant to them." – ISE2, Q128

Visually Appealing

The sub-theme of *visually appealing* was defined as "site looks good, includes images that make sense and text that is easy to read." Two quotes by two ISE participants were coded into this category and both are listed below.

"It's gotta look nice. I mean, I think more than anything, I mean, as I've worked in different organizations, you increase your traffic on your website if it's easy to navigate. If it looks good, if things make sense. So you need people to beta test a brand new website to make sure it makes sense. And you also need to test, those beta testers need to be answering questions not just about content or pretty pictures but um, usability and content. Are they coming here and finding what they came here for. What I'm looking for as a beta tester isn't gonna be what you would probably look for, or a teacher, or a 5th grade student for that matter. So it needs to be approachable from all those points, without being overly complicated." – ISE3, Q33

"I'm really all about clean design that uses lots of, like pictures or graphics instead of text. There are some websites that I have been to recently where it's just a pile of words and it's, for me that's really hard to sort of know where to go or what to do and I like the sort of 'choose your own adventure' type of like, being able to really find, like dig deep down into a website. You know there's theory out there about how many layers is too much for people to actually get to where they're going. And I don't know a lot of that technical stuff but as a user, I like to have it be very clear about where I'm going to get information. That's why I say the search feature. Just to be able to say, okay where is this thing, can you find it for me and go from there." – ISE2, Q130

Science Inquiry Quotes

The primary theme of *science inquiry* was used to code participant responses regarding science inquiry that did not relate to questions about their strengths and weaknesses as inquiry

educators and is divided into the sub-themes of *sparking inquiry*, *importance of inquiry*, and *mentoring.*

Sparking Inquiry

The sub-theme of *sparking inquiry* was defined as "getting students engaged in and excited about the inquiry process; including asking questions." Seven quotes by five participants (one licensed teacher and four ISE) were included in this category. Examples of quotes coded as *sparking inquiry* included:

> "I would say, especially at, from how I delivered it, was always at a waterfront. So allowing kids to feel comfortable to explore the area. I mean as long as you maintain safety, but kids will want to play in the mud and play in the water and look and inquire on their own. But a lot of times they come into the setting thinking that they're gonna have to follow rules and not get dirty and not, so um just allowing them to, making them feel comfortable to go and explore and that was okay and that was part of the process. And the best way to do that was pretty much to just model it; if you stuck your hands in the mud looking for aquatic invertebrates they were more likely to do so and continue the inquiry process on their own." – ISE6, Q75

> "I think that the inspiration piece is the big one. And I think about the classes that I'm successful with and then classes that I'm not as successful with, it's the difference between, again, going out and saying 'alright today we're gonna do a bug study' and kids are like 'aw, do we have to, I didn't bring my coat.' Or the classes that are saying, 'can we please go out, please can we get out tomorrow and do the bug surveys'. And it's palpable in classes and groups of kids where you can feel the difference between the point where you're forcing them to do something fun and they just really want to go do it, you know? And I think it's that inspiration piece, it's there. Because then, if kids want to be out there and they're really excited then they're gonna come up with great questions. But if you're kind of forcing them, they're just gonna come up with stupid questions and they're not gonna buy into the process as well." – LT1, Q95

> "And that's something that we really reinforce in our programming but the general public is really supporting the asking of questions that people feel welcome to ask and ask and ask and ask that's a really encouraging sign for me as an educator here, is to see people that maybe were hesitant at first but have that window of opportunity to, I think that's

> totally where it starts for people. Notice something and are inspired or encouraged to ask why." – ISE2, Q133b

Importance of Inquiry

The sub-theme of *importance of inquiry* was defined as "why it is important for people to experience the inquiry process." Nine quotes by five participants (two licensed teachers and three ISE) were coded into this category. Examples of quotes coded as *importance of inquiry* are:

> "I'll tell you what, I speak to the whole world on this one, is the standards are academically, are disrespectful to cognitive development and child development. And they are taking away everything, away from public education and they need to be stopped. The kids need help. Like they need to do inquiry, they would enjoy doing inquiry; and science right now is 'I'm gonna teach you some vocabulary' and it actually has nothing to do, 'I'm gonna teach you about desert communities, and prairie communities' and there's no value to go out and learn about a basswood tree out our back door." – LT2, Q112

> "In some ways I feel like your, the people that will be part of your project like this project, who are actually gonna be carrying out this inquiry with kids are the ones that sort of get it already. Like they realize it's important and want to nurture that ability in children. I think it would be really interesting to look at the, how to use something like this, particularly looking at successes with a program like this, to get the general public more excited about science inquiry and thinking about that science is something we do all the time. *[135a]* And something that we've struggled with trying to reinforce as an organization is that this concept that if kids come and just play here that somehow that's not learning or that's not discovery or like it's just play and that's something that I think is pretty pervasive right now across, especially in environmental ed[ucation], like trying to get the message out that when you're playing outside you're learning and certainly inquiry is more structured than that but it could be a vehicle for getting some pretty powerful stories about how these transformative kinds of experiences with science.... *[135b]* It could be a great vehicle for that, especially because kids stories are pretty powerful for the general public. You know for kids to be so pumped, and there, like the science fair world and like there are a lot of things and programs out there that are doing amazing work to engage and encourage kids in science but anytime you have this local focus too, you know something that's happening in Minnesota. *[135c]*" – ISE2, Q135a-c

Mentoring

The sub-theme of *mentoring* was defined as "when a more experienced person provides expertise to less experienced individuals to help them advance their careers, enhance their education, and build their networks." Seven quotes by four participants (one licensed teacher and three ISE) were coded as *mentoring*. Participants referred to mentoring both in the context of mentors for adult leaders and for youth participants. Examples of quotes in this category are listed below.

> "And if you could somehow, I think mentorship is a great way, if you could have someone that's a little more experienced with someone that's just starting out, that's a great combo." – ISE1, Q19

> "You know being able to get in touch with teachers who are working in the sciences, there could just be so many wonderful things happening. My experience with M and his citizen science with the worms, it could cause him to choose science as a career...but really I see that the time that this adult has spent with M as an 8th grader is totally invaluable. So if you're able to find the people who are willing to work with young folks, my, that's a wonderful, wonderful connection. And obviously, with my preferences, and my tendency to think about the Great Lakes, it's gotta happen because you're basically working in the watershed. No matter what you do." – LT3, Q49

> "We have been trying to do some modeling of what it means to be a scientists and um, provide examples and opportunities to see scientists that are, that look like them and are both men and women and that work both indoors and outdoors and try to get away from the sort of pre-conceived notion that a scientist is a white man in a lab coat indoors with test tubes. That seems to be the pretty common idea that that's what a scientist is so trying to help broaden that definition and that we are all scientists; that we all can ask questions and understand the world better." – ISE2, Q133a

Citizen Science Quotes

The primary theme of *citizen science* was used to code participant responses regarding citizen science in general and related to the experience of collecting citizen science data and is divided into the sub-themes of *how data will be used*, and *barriers.*

How Data Will Be Used

The sub-theme of *how data will be used* was defined as "knowing or understanding how citizen science data will be used by professional scientists." Three quotes by one licensed teacher and one ISE were coded into this category. Quotes coded into this category are:

> "I think I would include, what, whatever your project is driving at, like um let's say it's the monarchs, you should have, I can't remember her name right now, um, K [scientist participating in D2D project], you should have what she's trying to figure out and how this might help her. Um, so, like, in [another scientist] C's case with the worms she gets all this data from, well a lot of people are like, 'what good is it if I do one plot in my school forest, what is, what would she care'? But C always said, 'but if I get your data here and I get someone else's data here and I can kinda figure out where the leading edge of a migration is, then I'll put my transect from here to here, so it saves me all that groundwork of trying to figure out where the leading edge is.' So if you could, show that their input is valuable, or how it will actually manifest it in research, I think that's the, that's the key." – ISE1, Q13

> "If I were a citizen science group member working with children, I would need the directions, you know there would have to be someone there to teach me and the children about what we're doing and how this material is going to be used, the material that we collect. What other people have done, what other groups, where do we go, what site to use to find other data related to people doing the same thing. Not only in this country but maybe around the globe." – LT3, Q45

> [Speaking in the context of a hypothetical water quality monitoring citizen science team] "In that case, again, that whole concept of being educated and then being able to collect that data, know what's going to happen to it and how what we're doing might affect what could be happening to that stream or that river, as far as what the EPA might encourage people to do. You know that whole watershed aspect of that kind of learning for the children. Obviously if they're working with that water then they're going to be far more respectful. So all of those applications, those will just naturally come from teaching them how to gather the data and then recognizing what's going to happen to it, who's going to be using it and how it's going to be used. I may have gone around in circles there but I could certainly see being a really exciting activity for children. Because none of my students I've ever known have come back to me and said, 'You're not going to believe what we studied over the summer'. So I don't think anyone is, I shouldn't say that, no student I know has ever participated in something like that and I know many of them would have loved to have done so." – LT3, Q46

Barriers

The sub-theme of *barriers* was defined as "barriers to participating in citizen science" and appeared in one quote by an ISE.

> "I think that's where citizen science falls apart a lot of the times, because the leader or whoever has all the data sitting on their desk and it's just that drag to get it reported. Um, entering it in. So if there was some way to make that step happen, like, instantaneously I think that would be, I don't know if we're quite there yet but it's close." – ISE1, Q20 (excerpt)

Role of Technology

The primary theme of *role of technology* was used to code participant responses regarding their perceptions about what the current and potential roles and uses of technology as it relates to education and is divided into the sub-themes of *networking, resources,* and *resources.*

Networking

The sub-theme of *networking* was defined as "connecting with others for social or professional purposes." Five quotes by three participants (one licensed teacher and two ISE) were coded into this category. Examples of quotes coded as *networking* include:

> "Going back to that citizen science I really do think that, as D just said with fishing forums, same with birding things like Minnesota Ornithological Union, I don't even remember, listserv; the amount of information that comes out of that that could be beneficial to any sort of study that you were doing, you get 15 emails a day saying this is what was seen within a specific area, and you don't even necessarily have to go." – ISE5, Q54

> "And it's amazing that one thing the internet has allowed us to find is that citizen science really can be anywhere. And even if people aren't calling it that, it's happening. People watching birds in their own backyards and keeping data for the last 30 years. You may have, it may have happened but nobody was aware of it really until people started posting it on the internet. So I think that's one way that it, the web really can benefit that process." – ISE5, 80b

Resources

The sub-them of *resources* was defined as "informational resources" and included four quotes by two ISE. An example of a quote coded into this category is:

> "…And um, so I, in terms of what the web could do, you know it's certainly a resource. I mean, the internet is now the library, for kids. Unlike, how, what it is for me. Or what it was for me. So it's that kind of online resource they can go and find information. Now of course, we can debate all day long about whether that information is correct with things like Wikipedia or whatever. But, you know as a resource definitely." – ISE3, Q36 (excerpt)

Tools

The sub-theme of *tools* was defined as "things that are used to help accomplish a task in a more efficient or timely manner." Five quotes by three participants (one licensed teacher and two ISE) were coded into this category. Examples of quotes coded as *tools* included:

> "We just got iPads, and we're just starting to play around with those and those are really sweet. If you could somehow have loaner, a loaner set or um, but they have all the guides, you know they have all the guides there; you could do your mapping. I mean you could take a panoramic picture of your site, or your, and those are automatically data located and it's pricey right now but I think the, for citizen science, you could take a picture, load your data, it would automatically get tagged with data location and you'd ship it to your...and all that." – ISE1, Q20 (excerpt)

> "I was just gonna say, with the big push of grant writing in technology and the increased use of iPads & iPods, like having something on your website that can be accessible to those devices in the field, cause that's one way that you can get student use in the field and educator use, um if they can kind of plug that stuff in instead of pen and paper it, plug it in on the iPad that goes directly to your site or wherever. Just thinking towards the future needs instead of here and now." – ISE4, Q72

Barriers to Inquiry

The primary theme of *barriers to inquiry* was used to code participant responses regarding perceived or actual barriers to using science inquiry as an educational method and is divided into the sub-themes of *setting, time,* and *experience/qualifications in science.*

Setting

The sub-theme of *setting* was defined as "barriers to inquiry based on the setting where education is delivered; non-sequential contact with students" and was coded in four quotes by two ISE. An example of quotes coded into the category of *setting* is included below.

> "And so, given the nature of our facility, we're, we do, we typically have these one-contact experiences with kids. In my feeling, we would need to have more sustained contact with them to really support them through a longer experience. With like reflection and actually some meaning-making that's part of it." – ISE3, Q122b

Time

The sub-theme of *time* was defined as "barriers to inquiry based on the length of contact with students." Nine quotes from four participants (two licensed teachers and two ISE) were coded into this category. Examples of quotes coded as *time* are:

> "They sound neat [referring to the proposed social networking features of the D2D website and of VoiceThread]. I have absolutely no time for it [referring to scientific inquiry]. Again, it's third. Science is coming in third place. I don't have time. As much as I would love to have time, I mean I- in the more success I ever had in doing this, the more they pull me away from it and give you less and less time. The administration and the powers that be, they don't even want us doing that. Stick to your classroom." – LT2, Q101

> "But I feel like naturally inquiry is pretty time intensive and that's probably the area that we struggle with the most…" - ISE2, Q122d (excerpt)

Experience/Qualifications in Science

The sub-theme of *experience/qualifications in science* was defined as "barriers to doing inquiry based on the actual or perceived lack of qualifications or experience in science or with the inquiry process." Ten quotes by five participants (two licensed teachers and three ISE) were coded into this category. Examples of quotes coded as *experience/qualifications in science* are:

> "I think it's just being that guide. I mean you get students fired up about a topic and then you, they come to you with the questions. And then you, you guide that. Show them

resources. You're, you're going right along with them. So you don't, I think, a barrier for a lot of leaders is that they don't feel like they're qualified or experts to do this. But that's the beauty of it, I mean, they'll get, they'll get so much out of it themselves, cause they're learning. I think that's almost better if you're not an expert. Because then you're not, um, just likely to throw the answer right out. I mean you're kinda going along." – ISE1, Q18

"I agree with what these two have said. The only piece that I would have to add goes to what S said about tools. And the tools that I think could be useful are the actual data collection tools, or how you get the data into a usable form. Which I think can be really intimidating for folks, especially if they're not strong with their math skills or things like that. And I see this as a use for students if you could, you know, if you had a tool that was really easy to use. But also the adult leaders, adults who don't feel comfortable with that. If there was a developed tool that they could use that was very user-friendly; instead of like Excel or something like that where you're just plugging, if you're just plugging numbers in to a program, so then if Excel is not user-friendly, then they have to accomplish learning how to use the program before they can even get to the data analysis." – ISE6, Q64

"And then, because I know that, when I talk to undergrads, you know like especially education majors or like an elementary ed major, I say 'you don't have to be an expert to teach science, you just have to have an interest.' But you do need a certain amount of expertise, especially if you're doing a project like this." – LT1, Q88a

"So then you come to science, and there's a lot, there's a lot of teachers that are interested in science, but I think they get scared. I, you really get scared, cause they're not, and science needs to be presented, I believe at such a basic, basic level, yet not in a threatening way cause I guess if you're too condescending then they'll, you know they, 'Well we know this stuff'. But really they don't, they don't know it. And it's, so how basic..." – LT2, Q109

Connections to Research Questions

While themes, sub-themes, and associated quotes emerged as separate categories during the coding and data analysis process, it is important to note that most participants drew connections between the different themes. Participant responses to interview questions often spanned multiple themes. The most important connections across themes occurred in relation to

participant responses to interview themes that addressed primary and secondary research questions. Primary research questions and a summary of the themes that address participant responses to them are described first, along with examples of quotes from participants.

1. How do adult leaders describe the potential for using web-based technology as a means to achieve the scientist contribution to youth-based authentic science inquiry?

Participant responses addressed this question in several ways but most often their responses were grouped around ways to make connections with scientists and interactive website design features (sub-themes of *Ask an Expert/Scientist*, *Networking, FAQ, Data sharing* and *Live/Frequently updating/interactive*).

> "Um, a chat room. Or even like a weekly chat with varying scientists, or you could...like a bulletin board, like a place where you could submit questions or you know, requests for a resource and a professional would be able to get back to you. Think about the 24hour service you can get on, you know, different websites. Like, 'I have a question about how to do this' and someone gets back to you. 'I need to find this car part', you know and that kind of a resource." – ISE3, Q30

> "But I think what would make it unique is that interactive component. Someone is there to answer your questions. That this is a position that somebody has, like 'I am the biology person on call to answer this question about biology', whether that's from a student or a teacher or other professional." – ISE3, Q32

> "It might be kinda cool for the, the students too, another common question of our experts in the school forest too, is how did you get to where you were? Like what was the educational path, or um internships, and what does it actually take to get there and what can you expect when you do get there. So maybe even just a series of YouTube clips on your site of various careers that might be related to whatever topic you have and um, what their typical day looks like...and they're if they're super interested in what they're topic is and what, they could connect with them and they know that they're connected to the project already and would you know, it wouldn't be a blind request from, they're gonna know why they're contacting them." – ISE1, Q17

> "You definitely would want to have scientists where you can, you know, contact them. The website should be a base of contact, and not just names but put their pictures up there so you remember, 'oh I remember working with that person' and the bio and making that part personal so that, that's in that connection to the instructor." – LT2, Q105

> "And I was kinda thinking about well how are we going to stay connected with those scientists, because that was something that you asked and I mean, on the library websites they have that quick chat; you know like you can instant message the librarian and then they'll get back to you. Um, something that you can just send little quick snippets, and it doesn't have to be this formal process of I send you an email and I address you as sir or ma'am, and just to take away those barriers of formality, whatever they are." – ISE4, Q69

2. How do adult leaders perceive plans to develop a website to facilitate the ongoing relationship of scientists, adult leaders, and youth? What do they perceive as needs and barriers for using this planned website? What website characteristics would encourage them to use this planned website?

Participants generally responded to questions regarding role of the proposed website in supporting inquiry positively. They envisioned the role of the web as providing support through video tutorials, SmartBoard compatible lessons, mapping applications, networking, and as a source for resources (sub-themes of *Video tutorials, lesson plans, Mapping, Networking, Resource library, Data collection/analysis tools* and *Example projects*).

> "One of the very first things that that teachers have available to inquiry of course is the technology part of it. So anything related to the SmartBoard is one of the first places I would go. I'll just give you an example of something that we did, I'm just gonna throw out one experience, we encouraged the attendance of the master meteorologist I think might be his title from the weather station here in Duluth to come out and work with the kids and start teaching them about the weather. And we did a few experiments and then we did a virtual field trip whereby the children stayed in the classroom in front of the SmartBoard and he was out at his place and there was a third party involved...so we had a virtual field trip. And we could write on our SmartBoard and he could see it and he could do the same. And then we viewed, without having to get on the bus, what was going on and all of the interesting aspects

of working out there and what they do at the weather station. So that's the very first thing that comes to mind." – LT3, Q50

"So I would see, as the facility, how it stands now, um, the website would primarily be a tool for me as a non-formal educator, to then gain more resources or to, like S said, see where can I go from here. But again, because I teach non-sequential lessons, I see students once and then they're gone, it's hard to say, 'Okay, now go home and you know check this out and we'll talk about it tomorrow.' So as a non-formal educator, I think it would just be another tool in my tool box to help me improve lessons." – ISE4, Q58

"I think um, lesson plans is another thing. I mean if I'm going to be the facilitator or if I am working on this inquiry process teaching, you know things that will help get at the point we might be looking for. If it's curriculum based, if we're looking at standards. What's out there that I may not have thought about, or that some other teacher maybe came up with that was brilliant! Or even to find examples of 'this isn't gonna work'. So that, I guess really, the web would be just a reference, a resource library." – ISE3, Q37

Participants also mentioned potential barriers to using the web for inquiry and expressed skepticism about some proposed aspects of the site (sub-themes for barriers include *Setting/web access, Time, Perceptions/Have enough resources, Adult deader discomfort with technology* and design features sub-theme of *networking*).

"The networking, I just don't know if people will take the time to do it. Um, I may be wrong but, it seems like, we had a Master Naturalist chapter for instance, and it kinda flopped. Because people are just not, it's not where they want to spend their time. They want to be out doing the stuff." – ISE1, Q9

"So I'm thinking about this question [referring to the role of web-based technology in inquiry] and wondering if it's, you know I think about methodology. Can I use this in, can I use this web in my methodology, the website to help further the lesson. And I think that that would be a barrier due to the nature of the facilities that I teach at; because we are, I'm an outdoor educator and the agency that I work for, we don't have computers, we don't have iPads, we don't have things to use in the field with the students or even when we come back in to use with the students." – ISE4, Q57

"They sound neat [referring to the proposed social networking features of the D2D website and of VoiceThread]. I have absolutely no time for it. Again, it's third. Science is coming in

> third place. I don't have time. As much as I would love to have time, I mean I- in the more success I ever had in doing this [inquiry], the more they pull me away from it and give you less and less time. The administration and the powers that be, they don't even want us doing that. Stick to your classroom." – LT2, Q101

> "[Interviewer: If you were to say, Project Wet is gonna put a website together. What would you want it to offer you, that that book doesn't do?] Nothing. I mean the only place for that would be, and that's why I got excited for a bit with the phenology, because it was a place that the kids could go and insert their data. And that is, I could see a lot of use to that. A place where, any place a kid could come back and then insert their data. And use it in the, the web-based part as a kid's tool. A place to report, as a kids tool where they go through a scientific process or they could put their question in and, or even if the kids then could do more interacting with the scientist themselves. That'd help bring the scientist down to a little different level. Um, then I'd see it a lot more interactive. I mean, it would be, cause, you know, once I've taught a lesson once - I've gone through my information, I've studied something and okay here's what I want to do, when it comes back time to do it again, I'm probably not gonna go through that kind of work again. So I'm not gonna go back to a website, I'm not gonna go back to um, like my math book. When I went through it once last year, the teacher's manual, I don't go back to the teacher's manual anymore even. I just stick with the kids stuff and I work with the kids. And so anything that I could use to work with the kids and we're doing things together, that would be really valuable. If we're working together. Cause, shy again of just getting some sheets, just getting some worksheets, I'm not gonna go back for more information after I've done it once. I'll be very unlikely to go back, cause this is running at breakneck speed." – LT2, Q108

Participants had many suggestions for characteristics of website design that would encourage them to us the proposed site to support their inquiry activities with youth. Most of these responses were grouped together under the main themes of *Design Features* and *Design Characteristics* and included features like YouTube clips, search features, lesson plan extensions, places for youth to insert and share data, and characteristics like simple design, easy to navigate, and visually appealing use of pictures and graphics (sub-themes of *search feature, video tutorials, data collection/analysis tools, example projects, FAQ, photo gallery, data*

sharing, simple, easy to navigate, light text, live/frequently updating/interactive, multiple faces, and *visually appealing*).

> "And maybe part of it is, and having, and I think this is built in, but having a place to use their data once they've collected it. You know if they're, especially creating this video, you got me excited about that now. If only, and I wouldn't pick just the best ones but that there'd be some kind of criteria that if their video contained accurate information and that it was you know, well presented, that they'd actually get to put it up on VoiceThread or they'd get to put it someplace where people would see it." – LT1, Q93

> "It sounds like you might have multiple potential users for this site, that you might have those adult leaders, is the thought that kids might also be using the site? And so it might make sense that there are sort of different faces for each user. So maybe there's a general page but if somebody logs in, it kind of goes to what is actually relevant to them." – ISE2, Q128

> "I'm really all about clean design that uses lots of, like pictures or graphics instead of text. There are some websites that I have been to recently where it's just a pile of words and it's, for me that's really hard to sort of know where to go or what to do and I like the sort of 'choose your own adventure' type of like, being able to really find, like dig deep down into a website. You know there's theory out there about how many layers is too much for people to actually get to where they're going. And I don't know a lot of that technical stuff but as a user, I like to have it be very clear about where I'm going to get information. That's why I say the search feature. Just to be able to say, okay where is this thing, can you find it for me and go from there." – ISE2, Q130

Secondary research questions evolved from responses to emergent themes and generally include entire themes and all associated sub-themes.

3. What resources are adult leaders currently using to support inquiry? Are they web-based or hard copy?

Many participants indicated that they are using some combination of web resources and hard-copy resources to support inquiry (primary theme of *Current resources used for inquiry*, sub-themes of *web resources*, and *hard-copy resources*). Most inquiry activities that participants

referenced were related to the observation, questioning, and reflection stages of inquiry and therefore their choice of web resources generally reflects those aspects of inquiry. Participants had varying perceptions regarding the definition of inquiry and what activities it includes which is also reflected in their examples of 'inquiry resources'. Several participants indicated that they were using websites for resources and some were using sites for assessment or networking, however a notable number of participants indicated that they were not currently using any websites to support their inquiry work with youth.

> "Um, you know, other, I mean what I use personally - go on ERIC and go look up journal articles or things like that, when I think about my own kind of inquiry that I'm doing at my graduate level. But, as far as places where I would be you know, telling students to go, Wikipedia is most commonly used I think. But you know, you have to be really careful with you know, what you're citing out of those things." – ISE3, Q22

> "Right now my dream project is to incorporate Great Lakes literacy into our current curriculum. And so the principal at [local elementary school], what I taught last year, where I retired from, is allowing me to use all six levels, and I'm starting with the 3rd grade to make that effort to incorporate something particularly with Superior but with all of the Great Lakes, any of the Great Lakes...part of what I do..I'm using the Minnesota State Department of Education resource referred to as Frameworks and STEM...Oh my gosh, it is chock full of fabulous, fabulous things. And it's, the only thing that I've tapped into is the science and math and the technology part of it is the fact that they provide websites. And so that's where I have gone for a huge number of places. I love that whole Frameworks, it's really a super place." – LT3, Q39

> "I've been also frequenting a lot of sites of journaling and journaling methods to explore inquiry and looking at sample lesson plans and I mean there's just an array of you know, different types of journaling. That's something that our agency and our educational units have really been pushing for, is that, so methodology sites." – ISE4, Q55

> "So because I'm like living in this world of distance learning right now that we're starting this, sort of project right now. This is the Center for Interactive Learning and Collaboration. One of the things that I think is unique about them is that they, they're about video conferencing connections - which could be a tool that you use but doesn't have to be but one of the things that they have on their website is a collaborations page. And so you can search

ways that people have collaborated, students with each other or teachers with each other or students with an organization or they have all of these ways that people have used video conferencing to collaborate in the past. Or you can post to this and say I'm looking for a collaboration about, and I think that's a pretty awesome resource to have out there. I just mention that because I think something like that, depending on how you structure the website or how the project, or how people enter the program, it might be that they already know who they're collaborating with, cause that's been part of the process in getting them to where they're even part of, even accessing or aware of your website. So, I don't know if that's relevant...Or even in the reporting. They might be able to reach out and maybe there's a team doing the same kind of work somewhere else in the country and they can, or around the world and they can reach out and do a little mini summit and like talk about their work." – ISE2, Q114

"It's a different perspective to think about, using this website and internet access and technology. I'm well educated, I've taken courses at graduate level how to teach with technology in the field but I feel like I have these barriers because of my agency and the lack of support from management or the lack of support from actual tools, um, that I'm unable to incorporate these things. And part of that is probably just being young in the field and not being able to establish myself at one center for a while. Um, but yeah, it's something that I don't often think of and like I said, my students very rarely interact with technology, websites, whatever, due to the time constraints." – ISE4, Q56

"Of all the websites that I use, anything science related, the MorningEarth.org is what I use. But that's um, deep ecology type of stuff. So a lot of art & stuff...MorningEarth.org. John Caddy is his name and he's down at Forest Lake and I like his work a lot. Otherwise, I am, after I pound in vocabulary through our science book, I pound the vocabulary into them and then I spend my time with Project Learning Tree and Project Wild and Project Wet. That's, and so I don't know if I really, well I haven't at all become a good second grade science teacher so I'm not doing anything with inquiry." – LT2, Q97

4. How are adult leaders currently using the web?

Most participants indicated that they were currently using the web for information or networking for personal or professional purposes, most often through Facebook. Other web uses mentioned were mapping, geocaching, and banking (primary theme *Current web use* and sub-themes *information, networking, pleasure/fun, mapping*).

"I use Facebook myself a lot. I use it for my School Forest. Um, an awful lot." – LT2, Q100

"I think, I, I'm really big into mapping. And so I use GoogleEarth a lot, with both adults and these high school students. And they, they just, the power of that is, connecting data to locations. And so you get your specific data (here/years??) but how does that fit into the landscape scale, how do you rise up and see that bigger picture. I think that's the huge, and how do you connect with other, you know, other schools doing similar projects, and let's let's look at what their doing...I think that mapping function is really key." – ISE1, Q6

"It's just funny to look [at my bookmarks] and it's Facebook, or The Weather Channel, or my bank." – ISE3, Q23

"I just recently came across two websites, and I'll have to send them to you, but it's like it's designed for elementary through, elementary, middle, and high school science educators but it's like 'what is science? what is inquiry? how do we develop this?' and it's easy access to terms and questions and methods and tools um. And then there was an Earth encyclopedia that was really cool that I like." – ISE4, Q52

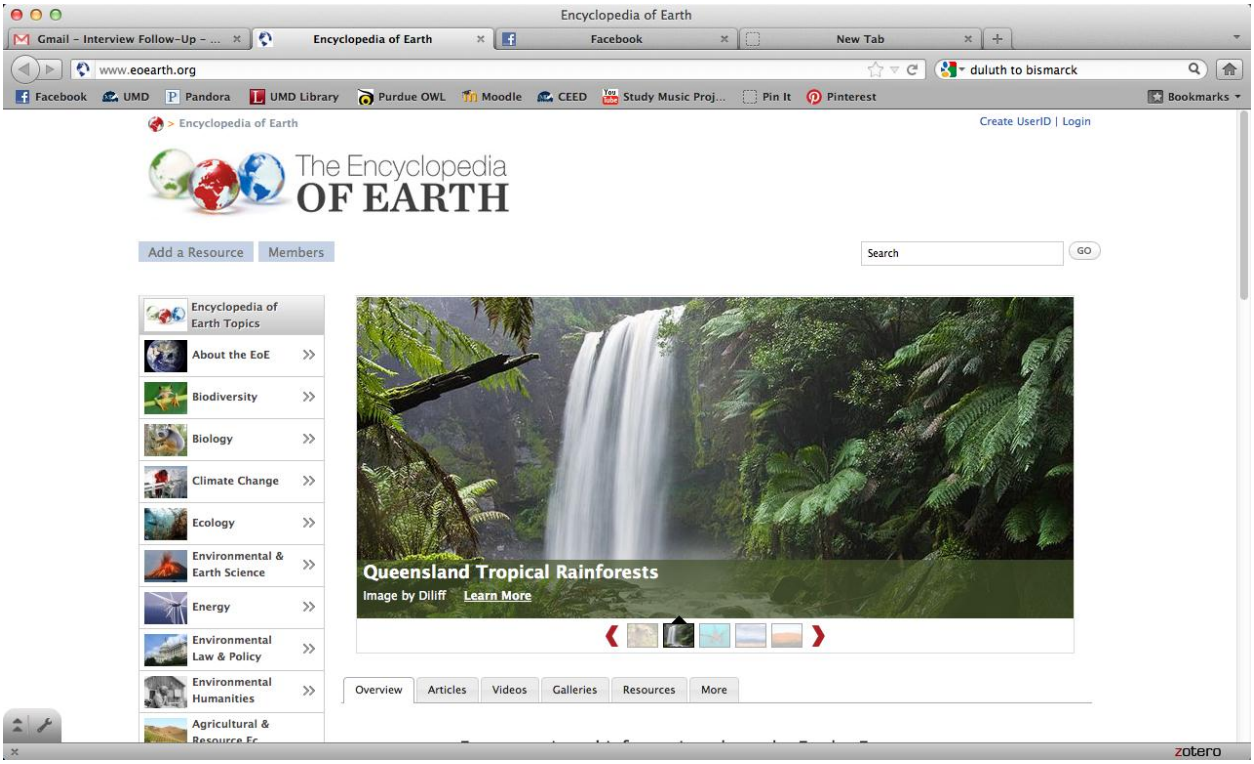

Figure 4 - The Encyclopedia of Earth; http://www.eoearth.org

5. What do adult leaders perceive as their strengths and weaknesses in the inquiry process and how might web-based technology supplement those areas?

Most participants felt that their strengths lay in the early stages of the inquiry process, mentioning things like being good at sparking interest and encouraging students to ask questions (primary theme of *inquiry process strengths*, sub-themes of *sparking interest, reflection, guided inquiry/observation, moving students to ask their own questions,* and *data collection/analysis*).

> "I would agree with these two, that my strength would be in embracing the question or coming up with good questions and embracing the unknown. Just like the process that it's okay to not know the answers and that experience is actually a life-long process. Where you don't need to always know the answers, and even I, as the leader, continue to not know the answer to questions. And I embrace that and I will use the tools that I'm showing them to learn myself." – ISE6, Q59

> "I think if given, like as an individual, given that opportunity that suddenly I have a science club of kids that want to do this project, I feel like personally I would feel pretty comfortable helping them get through. But I think there's always things that I could learn about moderating that experience; just from a few workshops I've been to and sort of conference presentations about inquiry. I mean, I think there are a lot of tips and tricks out there for getting kids from point A to point B and beyond. Even something like going from that collective brainstorm of questions and ideas to coaching without giving the answer, really, I think that that to me would be probably one of the more challenging steps; is having, helping kids make the decision, the decisions for how to answer their question. Knowing that some of those things aren't going to work out and that's part of the process and they have to try it and see." – ISE2, Q121

> "Places where I am best, when it comes to inquiry, is the exploration part of it. You know if students can come up with questions, I'm all about you know, figuring things out. Whether that's through play or organized classroom activities, um discussions, whatever it takes, whatever the students really direct; that's where my strength lies, is I can, I really enjoy and I feel like I'm very successful at those kinds of facilitating...to answer the questions more than coming up with the questions. Sure data analysis is part of that but you know it's, I feel less skilled at um, you know, creating the questions. Or you know, asking questions to get them

to ask questions...and that's something that I work on, but that's where I've got an opportunity for growth." – ISE3, Q27

When asked about their weaknesses within the inquiry process, participant comments reflected difficulties with beyond the beginning stages inquiry, such as moving students to ask their own questions, helping students determine testable questions, and data collection and analysis (primary theme of *inquiry process weaknesses* and sub-themes of *determining testable questions, moving students to ask their own questions, data collection/analysis,* and *drawing conclusions/sharing or using data*). Some participants noted their weak understanding of the inquiry process or how to assess the quality of inquiry learning in their students (sub-themes of *assessment of process* and *defining inquiry process/steps*).

"I feel like I could use a better definition of inquiry science. Like so that I, it's hard for me to even answer that question because I'm not sure I know all aspects of inquiry science but um, I would think so for me, one of my goals in teaching middle school has always been to really excite kids about science and get them involved and get them hands on. And then for me, in the past, data hasn't always been the important part. Like, the actual, like how the experiment turns out isn't as important as the actual just being involved in it. Or like the content, like I'll teach kids all the different orders of insects and whether they remember Coleoptera next year at this time isn't as important to me as them being super excited about where they found beetles or ah knowing that there's this huge diversity of organisms that exist on our planet that they didn't realize before. So I guess maybe the inquiry part that I would need help with would be the actual data collection part." – LT1, Q84

"Also, some kind of YouTube how-to's. You know like there's um, I think the thing that makes inquiry science the most intimidating to me is that it often requires use of some kind of technology or some kind of tools that I may not have had access to before. Or that I haven't used since college. And, so it would be nice to see somebody kind of doing it right. You know, a clip of somebody working with kids using the technology, watching kids use the technology, um." – LT1, Q86

"I feel I'm weakest at, kind of um, inspiring that, I can do, I can do a set project very well. Um, but I'm less, um, talented at that kinda, open ended realm. Where you kinda open it up and then it diverges. You know, that, how do you, how you, how do you facilitate that, um, I

think is where I'm weakest. Because I can, especially in a larger group, because you have so many different options, to me it kind of feels like it's, if I want to do a good job, I wanna focus in on one and follow them with that. Rather than trying to spread out with multiple." – ISE1, Q5

"I think that area which I would need most help personally would be in the assessment. I really like the process and I, actually I don't really care if the kids can pass a test on it. But if they had fun doing it and I feel that they were excited about it. I, I don't really care about the other, but I do value that in some areas. So it probably is something that I should have been a little bit more attentive about that. But I dont' know that I really wanted to spend that much time on it. So that would be one of my weak areas. In today's world though, where we have to document so much it's becoming more and more necessary to assess." – LT3, Q42

"The first time through inquiry you're not going to be good, as a teacher, let alone - I mean so forget about what you're giving to the kids, I'm saying just teaching it, you're not gonna be good. You're gonna stumble through it. And number one, teachers don't want the kids to know that you're stumbling through it so how do you stumble through this? How do you, you know, how do I have a disastrous lesson for four times before I figure this out. And I think that was my biggest fear, the biggest reason that I never got to good testable questions, is I got afraid. And I, I can be reckless in what I will try to do. There's other teachers that wouldn't even come close to being that reckless. When I, mean that just willing to put themselves out there and try. Because I did try a few times and it would never go anywhere. I'd even do, we had red wiggler worms and we'd try to do observations and come up with questions and it just never got good." – LT2, Q111

Chapter 5: Discussion

Introduction

This study sought to identify characteristics which would inform the creation of a website to motivate and enable adult leaders (licensed teachers, youth leaders and ISE educators) to use web-based technology to support youth in the authentic science inquiry process through the Driven to Discover (D2D) program. The researcher sought answers to the following research questions in order to provide recommendations to the University of Minnesota Extension Driven to Discover: Authentic Inquiry through Citizen Science project regarding the design features and characteristics of the proposed website.

1. How do adult leaders describe the potential for using web-based technology as a means to achieve the scientist contribution to youth-based authentic science inquiry?
2. How do adult leaders perceive plans to develop a website to facilitate the ongoing relationship of scientists, adult leaders, and youth? What do they perceive as needs and barriers for using this planned website? What website characteristics would encourage them to use this planned website?
3. What resources are adult leaders currently using to support inquiry? Are they web-based or hard copy?
4. How are adult leaders currently using the web?
5. What do adult leaders perceive as their strengths and weaknesses in the inquiry process and how might web-based technology supplement those areas?

Recommendations

Recommendations based on the results of interviews with nine potential adult leaders (six informal science educators and three licensed teachers) are organized into three general areas -

Supporting Inquiry, Making Connections, and *Visual Appeal and Usability,* and include supporting quotes and where appropriate screen shots of examples referenced by research participants.

Supporting Inquiry

Participants indicated that supporting inquiry should be a main focus of the proposed website. Based on the reported strengths and weaknesses of the participants, it is recommended that the D2D website incorporate the following bulleted action steps into the design of the proposed website.

1. Clearly define the inquiry process and how the steps fit together.

What does authentic inquiry look like to D2D? What are some strategies for getting youth through each step? What are some examples of good inquiry projects? Many participants did not have a clear understanding of the inquiry process as it aligns with the D2D project definition and goals. Clearly defining the inquiry process will help overcome uncertainty of adult leaders about the goals of inquiry.

> "I feel like I could use a better definition of inquiry science. Like so that I, it's hard for me to even answer that question because I'm not sure I know all aspects of inquiry science but um, I would think so for me, one of my goals in teaching middle school has always been to really excite kids about science and get them involved and get them hands on. And then for me, in the past, data hasn't always been the important part. Like, the actual, like how the experiment turns out isn't as important as the actual just being involved in it. Or like the content, like I'll teach kids all the different orders of insects and whether they remember Coleoptera next year at this time isn't as important to me as them being super excited about where they found beetles or ah knowing that there's this huge diversity of organisms that exist on our planet that they didn't realize before. So I guess maybe the inquiry part that I would need help with would be the actual data collection part." – LT1, Q84

By providing examples of quality inquiry projects completed by youth in previous years of participating in D2D or through other citizen science projects, both youth and adult leaders will have good models for structuring their research projects. As one participant mentioned, educators can often times construct their own paths towards an end goal or outcome if they know where it is they should end up.

> "Uh, a web base, would literally, I would see, a tutorial; the hardest one for me, I don't know if it was for others, was to actually come up with a testable question. And so what is a testable question, and what are some examples of a testable question, what, you know literally, what is it, what do they look like? Because I can get, if I knew, as teachers we know if I know that I want them to get to, I can get them there. I can get them to the testable, I can get them there. But what is it? Where are we going? And I know some of it, in order for it to be authentic it has to be the kids themselves coming up with it. But when that question happens you just don't know what to do with it. So really, I would think you'd need to be able to see questions and then see following it through then. What does a person do with that information? I mean, almost just a, a how-to, yeah a how-to, here's how to do it. And yet, keeping it basic." – LT2, Q104

> "I think including the examples for the youth could be really valuable too. Especially like, to spur, like you know, for them to shape their own learning. If these are students who might be returning for a certain amount of time who might be able to have a say in what the project is; if they had examples of different projects you know they could have a field day where they're interested in something but they haven't really figured out a way to regurgitate the information into like a science project or something like that but if they had example projects to look at, that might spark their interest in something that they've experienced already and then they can help shape the learning process themselves." – ISE6, Q67

Once the inquiry process has been clearly defined, D2D should include a list of tools and resources for each piece or step of the process, similar to the way that the Minnesota STEM Teacher Center's Frameworks for the Minnesota Math and Science Standards website includes supporting resources, methods, and activities for specific content areas related to STEM.

> "If you went the other way [referring to having students develop their own questions], I think something, a resource that does outline some of the, the ways people answer questions in

science would be really helpful. Like these little toolkits of like here was a question and here's how it was answered using these tools. You know, whether you did like four or five different varieties to kind of help kids begin to think about designing the strategy to answer your question." – ISE2, Q137

"I think for an educator, looking at you know, what are common things that I look at in lessons when I am diversifying, like what are extension activities. 'Okay so this is the way that it's written or this is the way that D2D says I should do it but it doesn't fit with my, the way I teach or you know, my group of students, or you know etcetera'; so having alternatives. Um maybe having a list of tools or resources, like we were talking about the KWL, the specific types of journaling, 'what are things that I can do to spark wonder', 'what are things that I can do to help students evaluate what happened?' You know, kind of like a top-five list for each of the um, areas in the inquiry cycle. Because then I can, I can go and I can read about it more and say, 'Okay well what methods really promote this section?' you know." – ISE4, Q68

"The other one that I have been playing around with lately is this; there's a STEM inquiry website that's amazing that a local teacher sort of turned me onto. And one of the things that I think is amazing about this is how comprehensive it is. Where you can sort of pick your topic - and this might be kind of where these might be the types of content areas that if you're going to do content areas within your website, so it's like Nature of Science, and Engineering, Physical Science, Earth Science, and Life Science. So if you were to click on that and say this is for first graders it will actually bring up in the Minnesota Standards what that looks like. And so for let's say inquiry is one of them, they have, they do a good job of saying like this is generally what you are teaching about, here's some of the misconceptions that kids have, they do a little story, like these vignettes, they do resources, they do a piece for parents like how to have this be reinforced with your parents or your administration, they do assessment, like all of this, it's all here. One of the things they have as resources are lesson plans but they also do different ways to sort of get out and get out and about. They do, there are technology resources, like lessons for SmartBoards and things that you can pull into your classroom that exist elsewhere like online that you can bring. And then they have a cross-curricular, so this is 'making kindergarten play into inquiry lessons' or how to incorporate it in language arts. So that has been really helpful for my staff in developing lessons that I think are actually, that might actually be inquiry. Like it's a good place to go. Cause somebody has already done all this amazing legwork that's Minnesota specific." – ISE2, Q118

"Right now my dream project is to incorporate Great Lakes literacy into our current curriculum. And so the principal at Lester Park, what I taught last year, where I retired from, is allowing me to use all six levels, and I'm starting with the 3rd grade to make that effort to incorporate something particularly with Superior but with all of the Great Lakes, any of the

Great Lakes...part of what I do..I'm using the Minnesota State Department of Education resource referred to as Frameworks and STEM...Oh my gosh, it is chock full of fabulous, fabulous things. And it's, the only thing that I've tapped into is the science and math and the technology part of it is the fact that they provide websites. And so that's where I have gone for a huge number of places. I love that whole Frameworks, it's really a super place." – LT3, Q39

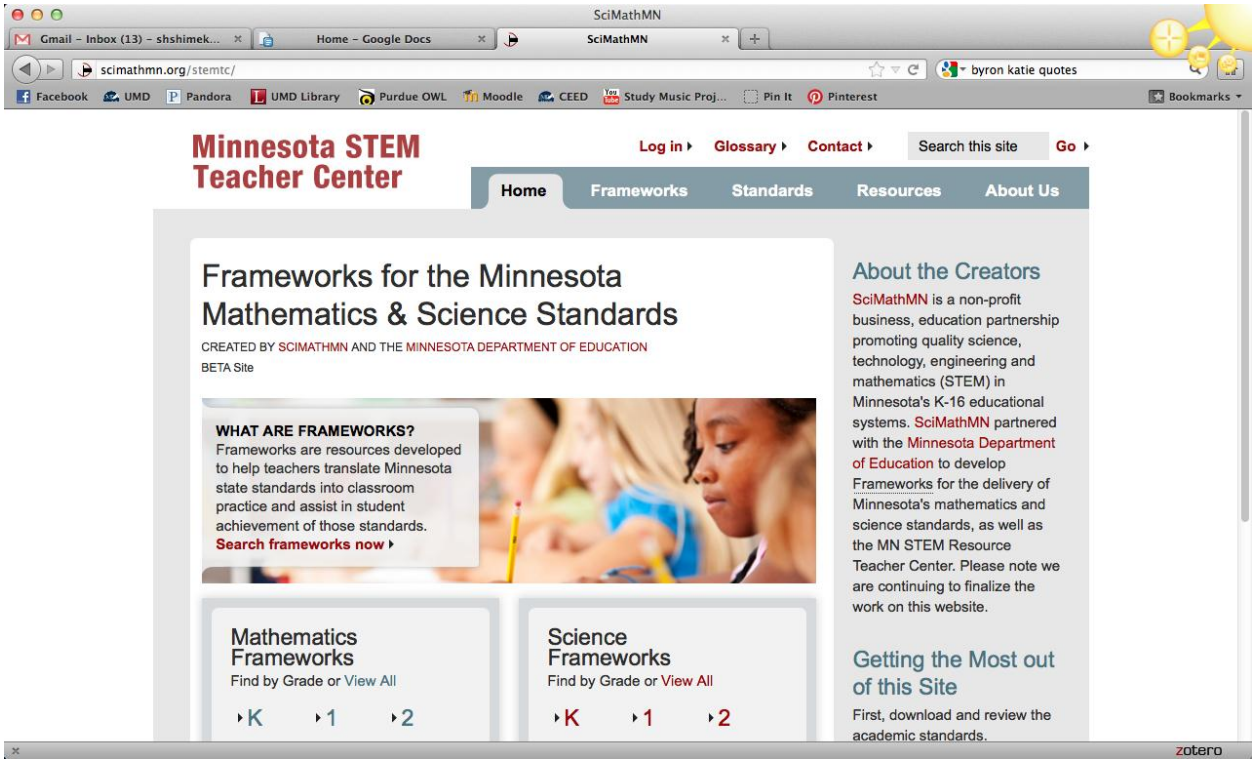

Figure 5 - Minnesota STEM Teacher Center: Frameworks for the Minnesota Mathematics & Science Standards, http://scimathmn.org/stemtc/

2. Include content background for citizen science projects.

What does a monarch caterpillar 3rd instar look like? Which birds are likely to be found in this part of Minnesota? Several participants indicated that while they might have a general background in science or ecology, they lacked the specific knowledge to facilitate the collection of citizen science data for professional scientists. By including content background for the citizen science projects on the website, D2D can help overcome a perceived or actual lack of science background in many potential adult leaders. Participants also indicated that having all the

necessary resources specific to their citizen science topic and region within the state in one place would make them more likely to use the proposed website.

> "Is it a data collection or data analysis website; that would be a lot different than is it for the youth to look at and say 'Here are 15 species of birds' just looking at the pictures and they can click on and find all of this information, this is what I want to focus. Is it a tool more for the youth or is it a tool for the adult supervisor who is helping guide them?" – ISE5, Q74

> "And then the, it is pretty intimidating to enter into, well to collect data for somebody else to me seems a little intimidating, because I'd want to do it right. And often, I don't beat kids up on data collection techniques, so like I just don't know what I'd do if we came back and a kid said 'I found...'. Like so here's an example, we were at Camp W last week and a kid told me that he saw a kingfisher, which it's, it, he didn't. I mean it would be very unlikely that that's what he saw, uh, and so we got the range maps out and we looked at it and the kid was still pretty sure that's what he saw, even though the range maps would indicate that they would not be here this time of year. And so I just let it go. But if we were actually submitting that data, I'd feel this added pressure of, um, I don't know, just an added pressure. Like what if kids are making mistakes, what if they are misidentifying things and yeah. So anyway that would be one of the pieces that I would feel like I would need some training on or some advice on." – LT1, Q85

> "And then, because I know that, when I talk to undergrads, you know like especially education majors or like an elementary ed major, I say 'you don't have to be an expert to teach science, you just have to have an interest.' But you do need a certain amount of expertise, especially if you're doing a project like this. If you're just going out and looking for bugs, that's so cool and kids should do it and you can just look at bugs. But if you're actually trying to figure something out, you gotta know what you need, and so I would say great images, great videos, and I would even say that they might be different videos for different parts of the state. Like I would love, what would keep me from being a part of the birds survey, is that I don't know all the bird calls. And I don't know if I can expect my kids to know all the bird calls. Maybe I could. But if I do what I would need is, I would need a site that says 'these are the 20 birds, these are the 20 birds that you're going to hear the most often.' And then I'd love to be able to cue my kids into that. And I'd even love to be able to give them to the sixth graders at the end of sixth grade and say, 'At the beginning of 7th grade you are really gonna want to know these 20 birds, so here's the CD or here's the site, study these this summer.' Because it doesn't do kids any good for me to know all the birds. I've had a lot of teachers that are like that, 'that's the pileated crowned crab eater' or whatever it might be. And I'm like 'oh great' and I write that down but I didn't really learn anything.

> And so, so anyway but I would need to have the knowledge and then I would need to be able to have a package that I could give it to kids, to disseminate." – LT1, Q88

> "So then you come to science, and there's a lot, there's a lot of teachers that are interested in science, but I think they get scared. I, you really get scared, cause they're not, and science needs to be presented, I believe at such a basic, basic level, yet not in a threatening way cause I guess if you're too condescending then they'll, you know they, 'Well we know this stuff'. But really they don't, they don't know it. And it's, so how basic..." – LT2, Q109

Participants indicated several websites that they felt provided a good model for resources, however many of them expressed negative opinions about how information on the website was presented. It is important to note that when designing the website and determining what resources will be included, D2D should be deliberate about the presentation of resources so that visitors to the site will not feel overwhelmed by the amount of information presented.

> "The other place that gets recommended a lot, to me, just because we're Lake Superior-based is the Lake Superior Streams website. I don't think it's as user-friendly as it could be, although they've done a ton of work on it and gotten awards and like...so they have data and live streaming data and resources for citizen science. You can search it, I feel like it could be layered differently. Like there is a lot happening, even on this homepage. And they are sectioned by community and who might be using things. But I, I would organize the information differently to get to where I want to go. I have looked at this to try and point, especially schools toward resources, and I know that N has worked on parts of this, 'cause Water on the Web is like linked to this in the past and SeaGrant has worked on it a ton. And so there's some really cool stuff going on here. I just haven't always found it the easiest to get around or sort of know where I am or what I'm looking for or trying to find. But there's tons of information, there's tons of resources there." – ISE2, Q117

Figure 6 - Lake Superior Streams.org; http://www.lakesuperiorstreams.org/index.html

"I haven't used this very much but it keeps getting promoted through COSEE and stuff that there's tons of data already online that people can use. This is Teaching with Great Lakes Data." – ISE2, Q116

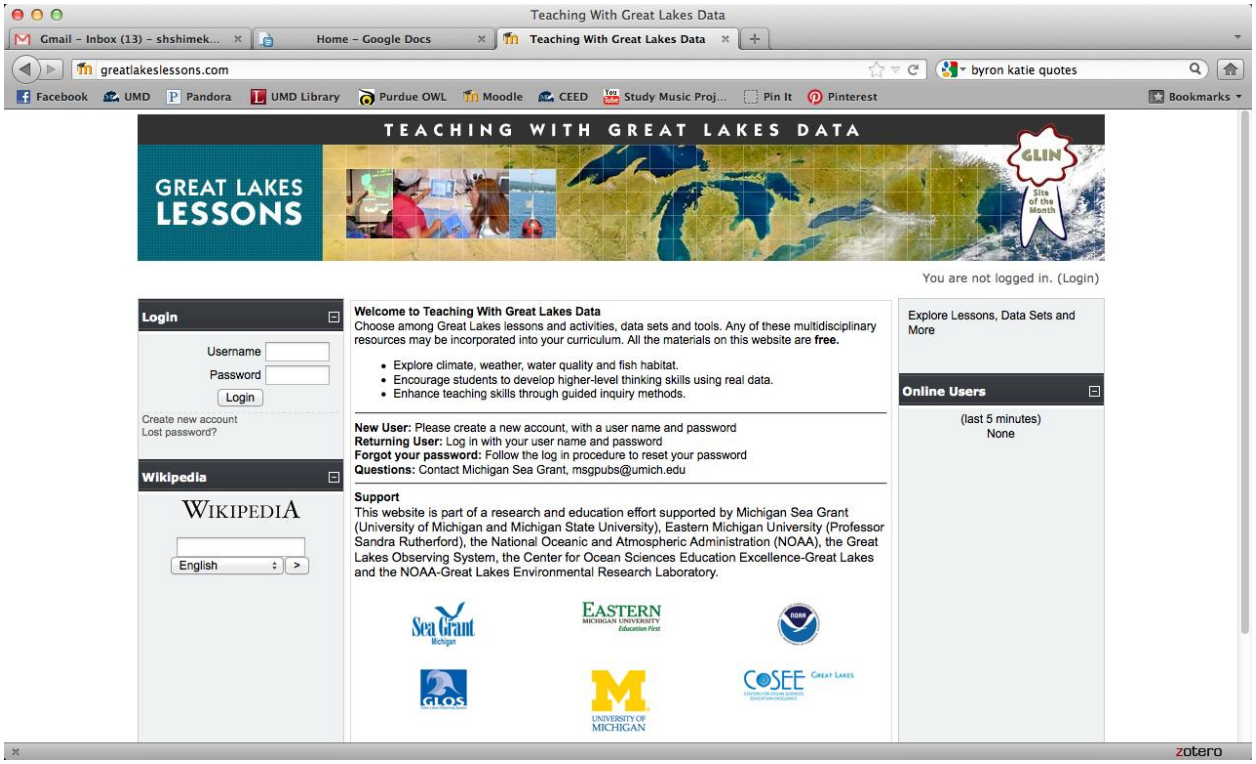

Figure 7 - Teaching with Great Lakes Data; http://www.greatlakes.com

> "I know D mentioned, in the past the [Minnesota] DNR website was not as functional as it could be but I think it has improved greatly. They have a lot of education pieces, whether it be on digital photography or the trail cams, um with a fair amount of resources. Web 2.0 things that can be very beneficial; maybe not the inquiry part but getting resources to start a project. Also SEEK Minnesota, I think is the website (ISE5)...there's a SEEK Wisconsin one too that I like; or EEK. E-E-K (ISE4)....well this is SEEK but based on environmental education. (ISE5)" – ISE 4 & 5, Q52

3. Support youth research projects.

Is my question testable? Now that I've collected data, what do I do with it? Most participants indicated a level of uncertainty with determining which questions were testable and how to analyze and present data once youth have collected it. Providing support and methods on the website can help overcome adult leader uncertainty with determining testable questions.

> "Places where I am best, when it comes to inquiry, is the exploration part of it. You know if students can come up with questions, I'm all about you know, figuring things out. Whether that's through play or organized classroom activities, um discussions, whatever it takes, whatever the students really direct; that's where my strength lies, is I can, I really enjoy and I feel like I'm very successful at those kinds of facilitating...to answer the questions more than coming up with the questions. Sure data analysis is part of that but you know it's, I feel less skilled at um, you know, creating the questions. Or you know, asking questions to get them to ask questions...and that's something that I work on, but that's where I've got an opportunity for growth." – ISE3, Q27

> "So I was really big into observation, and journaling, and writing and I guess that's my language arts background, and then correlating that into science. We never really did get good at research, myself. And getting those kids to ask those driving questions and then testing them, testable questions. And probably could have used a lot more help in getting kids to that point. And then, because I even had a friend...who would try and help me with that, but without the science background it was hard to do that." – LT2, Q103

> "But I've seen a few folks speak that had great suggestions for how to narrow down from the, this like huge cacophony of ideas to things that were actually testable within the given time frame and with the resources they had and so that skill of being able to guide kids down a path where they're actually making the calls but from within a certain range of options. Like 'oh we don't have our own satellite, so how can we get that information? How, we don't have the huge piece of equipment that we need to analyze these samples so how, where do we go from there? Who do we reach out to?' I mean I think that there are some pretty awesome examples of kids doing science...I think that there are lots of other ways that kids can have an experience in science that's meaningful to them. But that piece, that sort of navigating all of the possibilities to a few that are actually doable." – ISE2, Q123

> "But that knowing more about the ways, I think one of the things that is often a mystery to kids coming here, even adults, thinking about how science works, is how you actually, what's available for you to use as a tool to get the answer. Can you just make an observation with your own senses or do you need some added level of technology or I mean there are a lot of questions you can answer just using your own observation skills but um, knowing kind of what that catalog of options is, I think is a, would be an interesting resource to have. To sort of think through, like how do you help kids understand which questions, when do you use a lab or when do you use the field or when do you have to use other tools or techniques or even develop a tool that hasn't existed before to find out more." – ISE2, Q134

Participants also indicated that the proposed website should provide strong support and tutorials for data collection and analysis procedures.

> "I would say that I also am pretty comfortable at sparking interest and coming up with a testable question and even doing data analysis and looking at what the data could mean, but what I, where I think I would need help on and where I could improve is what you're gonna do with that data then. So you have this data that could actually, I don't know, conclude something, but where are you gonna focus that on? And I would assume that would have more, a lot to do with the question, and maybe that where I think I'm good and I'm not actually meeting all the needs. But really what then, how are you going to use the data to come up with a conclusion or change something either about your program or about the environment that you were trying to test in the first place. (ISE5)...And/or make it applicable to the students' lives. You know that last connection of 'so you're here, so now what'. (ISE4)" – ISE 4 & 5, Q60

> "I again would say that the data analysis process would probably be a weak point but I agree with what [ISE5] said about not knowing where to take it. Even if I were to do it correctly or in a good manner, not knowing where to take it or what the students could walk away with like, 'I've learned this'. Or especially getting them to understand that it's a small piece of the puzzle and that the scope of this project that they're involved with might not be able to allow for answers or conclusions to be drawn but they're helped in a, they've helped by putting one piece of the puzzle in." – ISE6, Q62

> "I agree with what these two have said. The only piece that I would have to add goes to what [ISE5] said about tools. And the tools that I think could be useful are the actual data collection tools, or how you get the data into a usable form. Which I think can be really intimidating for folks, especially if they're not strong with their math skills or things like that. And I see this as a use for students if you could, you know, if you had a tool that was really easy to use. But also the adult leaders, adults who don't feel comfortable with that. If there was a developed tool that they could use that was very user-friendly; instead of like Excel or something like that where you're just plugging, if you're just plugging numbers in to a program, so then if Excel is not user-friendly, then they have to accomplish learning how to use the program before they can even get to the data analysis." – ISE6, Q64

Making Connections

An important component of the D2D project is establishing and maintaining a relationship with a professional scientist, therefore discovering potential adult leaders perceptions towards the role of the proposed website in maintaining a connection with scientists was central to the

research questions. It is recommended that the D2D website incorporate the following bulleted action steps into the design of the proposed website.

1. Facilitate connecting with scientists.

Why is citizen science important? How did the scientist get where they are today? Participants indicated that the proposed website should play a role in providing opportunities for 'live' interactions with scientists and help advance the perception among youth that scientists are 'real people' too. 'Live' interactions could be accomplished through the use of web cams or Skype, virtual fieldtrips, and live chat or 'office hours' features where youth and adult leaders can interact with professional scientists in real time.

> "Um, a chat room. Or even like a weekly chat with varying scientists, or you could...like a bulletin board, like a place where you could submit questions or you know, requests for a resource and a professional would be able to get back to you. Think about the 24hour service you can get on, you know, different websites. Like, 'I have a question about how to do this' and someone gets back to you. 'I need to find this car part', you know and that kind of a resource." – ISE3, Q30

> I remember several years ago, when I first started working with SmartBoard, I wanted to do a virtual field trip through either NASA or the Smithsonian as it turns out. And I couldn't afford them, 'cause they were pretty pricey. But I ended up finding a place where I could go and ask questions of a person. So I'm actually emailing back & forth with this NASA guy. And, oh my gosh, that just served so many purposes and it just turned out I couldn't afford it. But what a treat that was to be able to, I mean, to talk to NASA. That was pretty top drawer as far as I was concerned. – LT3, Q48

Participants also suggested that the website include profiles of the research scientists working with the D2D project which would include bios and video clips which showed 'a day in the life' of the particular scientist along with information about how they got started in their field.

"It might be kinda cool for the, the students too, another common question of our experts in the school forest too, is how did you get to where you were? Like what was the educational path, or um internships, and what does it actually take to get there and what can you expect when you do get there. So maybe even just a series of YouTube clips on your site of various careers that might be related to whatever topic you have and um, what their typical day looks like...and they're if they're super interested in what they're topic is and what, they could connect with them and they know that they're connected to the project already and would you know, it wouldn't be a blind request from, they're gonna know why they're contacting them." – ISE1, Q17

"You definitely would want to have scientists where you can, you know, contact them. The website should be a base of contact, and not just names but put their pictures up there so you remember, 'oh I remember working with that person' and the bio and making that part personal so that, that's in that connection to the instructor." – LT2, Q105

Several participants also recommended that the website should include ways in which citizen science and youth data help scientists answer their own research questions.

"I think I would include, what, whatever your project is driving at, like um let's say it's the monarchs, you should have, I can't remember her name right now, um, [University of Minnesota scientist], you should have what she's trying to figure out and how this might help her. Um, so, like, in C's case with the worms she gets all this data from, well a lot of people are like, 'what good is it if I do one plot in my school forest, what is, what would she care'? But C always said, 'but if I get your data here and I get someone else's data here and I can kinda figure out where the leading edge of a migration is, then I'll put my transect from here to here, so it saves me all that groundwork of trying to figure out where the leading edge is.' So if you could, show that their input is valuable, or how it will actually manifest it in research, I think that's the, that's the key." – ISE1, Q13

"I feel like it could go a couple of ways, I think depending on how you'd want the experience to be structured and I don't know all of this, or literature behind inquiry, you know about whether or not, whether it makes it more meaningful to somebody to have developed that question themselves or to feel like they're helping to answer a question that somebody else has. You know so if, for instance if you went sort of that, in that route that like 'Here are sort of real questions that are out there that would help people move forward on an existing project'; you, so a website could have some of those big ideas, you could sort of have this bank of ideas that you know a group of kids could come together to help someone already in the field get there. And I think there would be some sort of amazing opportunities for interaction with scientists or field teams that way, that you'd have some mentoring and

> modeling while the kids were actually helping, And that's I guess sort of where citizen science comes in; that you're actually helping with an existing investigation." – ISE2, Q136

2. Facilitate sharing the research.

Several participants agreed that the proposed website should provide opportunities for youth to share what they learned through their citizen science data collection and individual research projects and in turn learn about what others are doing in inquiry science.

> "It would be just so cool, because it, I don't know, cause it'd be fun for kids to have a way to put together a short presentation and a short clip on what they did then and a place to post that where other kids can look at it." – LT1, Q92

> "And maybe part of it is, and having, and I think this is built in, but having a place to use their data once they've collected it. You know if they're, especially creating this video, you got me excited about that now. If only, and I wouldn't pick just the best ones but that there'd be some kind of criteria that if their video contained accurate information and that it was you know, well presented, that they'd actually get to put it up on VoiceThread or they'd get to put it someplace where people would see it." – LT1, Q93

Some participants indicated that they would like to see the website include examples of how the data that youth citizen science research teams are collecting will/is be/ing used to increase knowledge or make change. An example would be the Encyclopedia of Life: Global Access to Knowledge about Life on Earth, which allows members to upload information and photographs of current biological research.

> "If I were a citizen science group member working with children, I would need the directions, you know there would have to be someone there to teach me and the children about what we're doing and how this material is going to be used, the material that we collect. What other people have done, what other groups, where do we go, what site to use to find other data related to people doing the same thing. Not only in this country but maybe around the globe." – LT3, Q45

"[Speaking in the context of a hypothetical water quality monitoring citizen science team] In that case, again, that whole concept of being educated and then being able to collect that data, know what's going to happen to it and how what we're doing might affect what could be happening to that stream or that river, as far as what the EPA might encourage people to do. You know that whole watershed aspect of that kind of learning for the children. Obviously if they're working with that water then they're going to be far more respectful. So all of those applications, those will just naturally come from teaching them how to gather the data and then recognizing what's going to happen to it, who's going to be using it and how it's going to be used. I may have gone around in circles there but I could certainly see being a really exciting activity for children. Because none of my students I've ever known have come back to me and said, 'You're not going to believe what we studied over the summer'. So I don't think anyone is, I shouldn't say that, no student I know has ever participated in something like that and I know many of them would have loved to have done so." – LT3, Q46

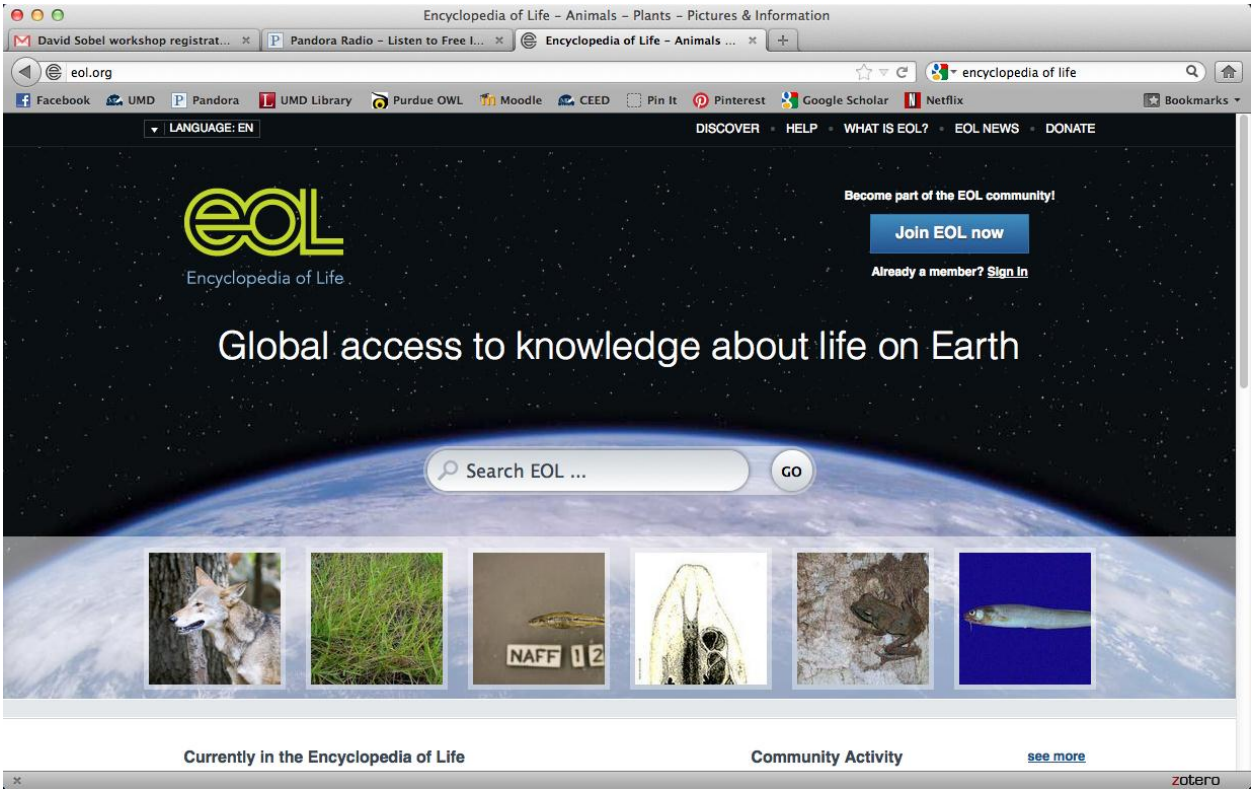

Figure 8 - Encyclopedia of Life: Global access to knowledge about life on Earth; http://www.eol.org

3. Support mentoring relationships.

Did you know that kids could be scientists too? Hanging out outside and making observations is science and could lead to a career later in life! Participants mentioned the importance of supporting a mentoring relationship between scientists and both adult leaders and youth, as well as mentoring of new leaders by experienced adult leaders. They also commented on the importance of modeling a more inclusive representation of who can be a scientist and what science is.

> "And if you could somehow, I think mentorship is a great way, if you could have someone that's a little more experienced with someone that's just starting out, that's a great combo." – ISE1, Q13

> "We have been trying to do some modeling of what it means to be a scientists and um, provide examples and opportunities to see scientists that are, that look like them and are both men and women and that work both indoors and outdoors and try to get away from the sort of pre-conceived notion that a scientist is a white man in a lab coat indoors with test tubes. That seems to be the pretty common idea that that's what a scientist is so trying to help broaden that definition and that we are all scientists; that we all can ask questions and understand the world better. And that's something that we really reinforce in our programming but the general public is really supporting the asking of questions that people feel welcome to ask and ask and ask and ask that's a really encouraging sign for me as an educator here, is to see people that maybe were hesitant at first but have that window of opportunity to, I think that's totally where it starts for people. Notice something and are inspired or encouraged to ask why." – ISE2, Q133

> You know being able to get in touch with teachers who are working in the sciences, there could just be so many wonderful things happening. My experience with M and his citizen science with the worms, it could cause him to choose science as a career...but really I see that the time that this adult has spent with M as an 8th grader is totally invaluable. So if you're able to find the people who are willing to work with young folks, my, that's a wonderful, wonderful connection. And obviously, with my preferences, and my tendency to think about the Great Lakes, it's gotta happen because you're basically working in the watershed. No matter what you do. – LT3, Q49

> "From some of the comments made it seems like the program is probably onto this train of thought already, but to connect that any way they're enjoying the natural world when they're out there, whether they really like frogs or turtles or bugs or flowers or whatever, there

> seemed in my youth to be a disconnect between that and the fact that that is science and there is science there. I didn't know that, until really later in life and that their interest in science can lead to a profession and you know, the interests and the tangibles the things they can put their hands on and feel, can lead directly to professions in that field." – ISE6, Q79

Visual Appeal and Usability

Participants had many recommendations for aspects of the visual appeal and usability of the proposed website that they felt would make them more likely to use the website. It is recommended that the D2D website incorporate the following bulleted action steps into the design of the proposed website.

1. Keep it simple & organized.

Several participants spoke strongly about the importance of keeping the design of the website simple and easily navigable. When designing the proposed website, D2D should make sure that there is a functional search feature that is accessible from every page, and that active links to not only the home page but all other pages are accessible from every page. Designers should also avoid having too much text on a page or having too many layers of tabs and links to navigate through.

> Most large government websites turn me off because of the clutter and that's one thing with any website is that it, it really needs to be user-friendly, as [ISE6] & [ISE4] mentioned. [ISE5]...Visually appealing, that you can visually move and kind of navigate quickly without lots of scrolling and [ISE4]...and an easy find. If you already know what to look for, an easy find tool where I think a lot of websites don't seem to have that; but it depends on what the focus is. [ISE5] – ISE4 & 4, Q73

> I want to highlight what [ISE5] said that I think might have just got flown past, that the really easy search tool is like huge. And for, like you can kinda hit and miss with your website layout but if you nail your search tool, you know people are gonna be content because they're gonna be able to get to where they want to go. And, you know, I remember three or four years ago, the [Minnesota] DNR website, the search tool was terrible. And it's slightly gotten,

it has gotten better. But a lot of people are drawn to that search tool immediately; they won't even spend the time exploring the website, they'll go right to the search tool. And I don't even know the science behind how you make that a good tool but [ISE6]...developing a systematic approach to it [ISE4]...right. Have Google do it. [ISE6] – ISE4 & 6, Q70

One of the other, I think it should have some kind of search feature. I hate going to websites that don't and you end up having to navigate like crazy. – ISE2, Q127

"A main page, on the main page it says what are they, what is this. [Referring to the Geocaching.com site] And it gives very simple steps: "One browse here, two discover what it's about, and three share your experience". And then the tabs on the top, you know, you scroll over them and the drop downs appear. You don't have to click a lot, you can just kind of, your mouse just wanders and it'll expose new things. You know but then the headings on these are very well thought out. Like, what's under 'Learn' belongs under 'Learn', 'Your Profile' everything belongs under, it all makes sense where you're going and you know this has a discussion forum. So it's an external link [Groundspeak.com] and you click on that and it goes to this bulletin board and it, I mean the bulletin board, they're very very smart with how that's broken up. You know, how the notices are here from the actual organization, from the company, general discussions, different components of the game, So it makes sense as you're looking it over, for like, you know I really want to find out how to do this, I wanna figure out how to play this game in Minnesota. Well then you go down to where it says 'Geocaching groups by region/state', Oh my goodness, it makes sense I can find it here'" – ISE3, Q34

Figure 9 - Geocaching.com; http://www.geocaching.com

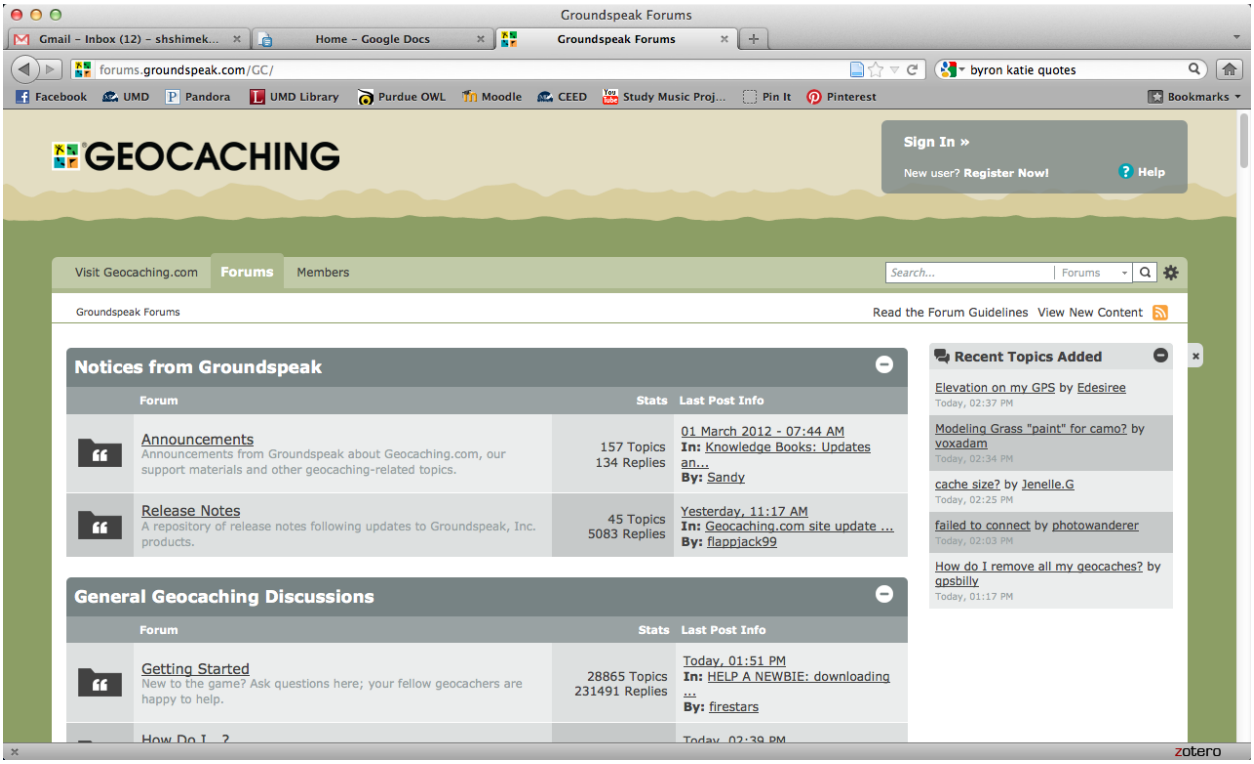

Figure 10 - Groundspeak.com; http://www.forums.groundspeak.com/GC/

2. Use visuals in a deliberate and thoughtful manner.

Participants agreed that the website design should incorporate pictures and videos, both for supporting resources and for keeping the site interesting but they should be used deliberately so as not to visually overwhelm visitors to the site.

> "If you're gonna have kids go through to that point of sort of reporting back on their data, something that we've been asked a lot for, as an aquarium from kids and adults, are photos. And so having a photo library with images that seem relevant; it kind of [unknown, grows?] even. I mean it could be those content areas, so like general pictures that might be useful for kids to use that they know they can use with permission, like without permission or even if as a place to, for them to upload their own images of what's going on. Something about pictures I think would be useful. And that's something that we've found to be one of the biggest challenges in our own work to is trying to source good photos that...even thinking about kids

making a poster for some sort of a reporting session. They might have their own equipment to take those photos, but they might not. And so that's gonna be a barrier to them doing this project then maybe we can sort of help out." – ISE2, Q126

"Also, some kind of YouTube how-to's. You know like there's um, I think the thing that makes inquiry science the most intimidating to me is that it often requires use of some kind of technology or some kind of tools that I may not have had access to before. Or that I haven't used since college. And, so it would be nice to see somebody kind of doing it right. You know, a clip of somebody working with kids using the technology, watching kids use the technology, um." – LT1, Q86

"So, for me, I would need for like the larva project...but um I think the big key thing for me would be great pictures of larva and if there's diseases or whatever they're looking for, great images." – LT1, Q87

3. Incorporate user specific entry points or "faces" for different users.

Participants suggested that D2D incorporate different entry points for different visitors to the site as a way to organize relevant information. They suggested that while all site visitors might enter the site through a main homepage, the website should include youth specific and adult leader specific sub-pages.

I think you could easily have, the quick thing is having two websites. Or I mean you show up at one but 'for adults', 'for youth'. Because it really, they really are, should be different focuses. As I said before, having a data analysis thing for adults would be really beneficial. And also a, a 'what are good examples of science inquiry?' 'What are past projects that have really worked?' For youth, having a lot of visuals (ISE5)...lots of visuals (ISE4)...visuals, audio, videos that can really say, these are the type of species - whether it be animal, plant, whatever, that I want to study. And going back to the butterflies, having projects that have already been used in the monarch or bird species within their local area. (ISE5) – ISE4 & 5, Q66

It sounds like you might have multiple potential users for this site, that you might have those adult leaders, is the thought that kids might also be using the site? And so it might make sense that there are sort of different faces for each user. So maybe there's a general page but if somebody logs in, it kind of goes to what is actually relevant to them. – ISE2, Q128

This is that organization that I had worked for in Rhode Island, Save the Bay and they work on Narragansett Bay and they actually have several, I actually mention them in part because they have a really strong youth program and the kids do, they raise eel grass in their classrooms and actually go out and plant the eel grass...But they have a whole youth section to their website that is all about sort of how you take action. And they use this little character, to sort of talk to kids, Scuba Steve, and he talks about how to help. And so they have this whole very youth driven, like what can kids do to help. And so this part of their website I like. I am not a huge fan of like this font or whatever but I think it's pretty comprehensive as far as the stuff. – ISE2, Q113

Figure 11 - Save the Bay: Narragansett Bay; http://www.savebay.org

4. Aspects of the site should be constantly maintained and updated.

When designing the proposed website, D2D should strive to make the site as interactive and 'live' as possible. Participants agreed that while some features should be static resources, they were more likely to return to the site if they knew there would be new information available.

"But I think what would make it unique is that interactive component. Someone is there to answer your questions. That this is a position that somebody has, like 'I am the biology person on call to answer this question about biology', whether that's from a student or a teacher or other professional." – ISE3, Q32

"You know there's a really clear frequently asked questions part that's on there, that's, I think, no matter what site I've ever been to, that's been an example of really poor websites, or really good websites. That there's always going to be commonly asked questions and that can't just be some static page that is saying like, you know, 'How do I email someone?', like 'How do I...' like it needs to update. Because over time, you're gonna realize that, ooo, that's a really good question that we should pin on the front page so people can find it. You know, if everybody is asking 'Where can I find this resource' that should become, you know, something right on the frequently asked questions. I mean that's something that cognitively, like 'I have a question. Oh frequently asked. Maybe it's here' you know verses having to dig for it. Perform a search either on the site or Google, Yahoo, whatever...So it's not just a guess. Some of them are gonna be canned response, like 'what is your address', 'how do I find you', 'who do I contact for this' but then the bigger questions that are gonna start to be noticeable as regular questions. So someone should really by staying on top of updating that." – ISE3, Q35

"Well here's a dream, that they could be interactive. Yes. So if they're, let's say that you were the person in charge and so I emailed you okay I'm going to be a citizen science, scientist, group member, and I'm new to it and I google citizen science, you're something that comes up. And so, I would find your site and I would not only be able to investigate what's there but let's say that I'm looking for something and I can't find it anywhere, and I really have such a unique skill, let's say, my skill set is whatever, something that's very very unique but I know that it could be useful. How could I use your site if I couldn't talk to someone to say 'Well you might not have noticed in the River Watch, we could use someone with your skills'. That's just an example." – LT3, Q47

"The National Zoo. One of the things that I think they do in a really unique way...they have a digital exploration part of their website. And they, where you can sort of tromp through the woods and then it's up to you to sort of pick things up and turn things over and then you can do like a little soil science activity. *[115a]* I think I like their website as an example of a very clean, easy to use. Generally their stuff is pretty good. *[115b]* In here they have like a homework helper so you can ask questions. They have like live webcams that are like out and about that people can use. And I think it might be this biodiversity in the classroom that's the interactive page. They're, because they're national they're tied in with the Smithsonian. And I think Smithsonian also has some really amazing resources online. I think the Smithsonian education in general does really amazing. *[115c]"* – ISE2, Q115

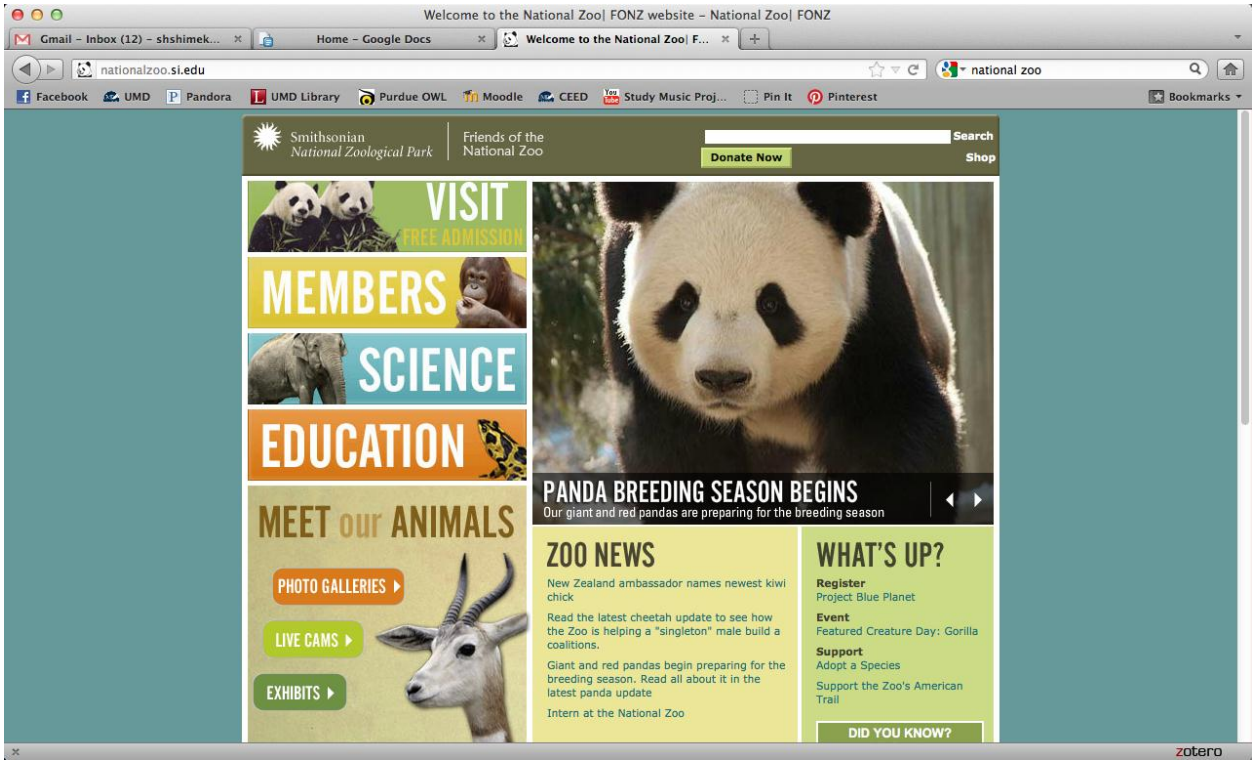

Figure 12 - The National Zoo; http://www.nationalzoo.si.edu

"But I could maybe see like a, a resource, question/answer type thing. Like, I think "My Minnesota Woods", N will be aware of this site, I think they kind of modeled it after, in the video he kind of mentioned it, E who manages this site, he get, if anyone posts anything anywhere, he gets back really quick. Like answers or other resources that they can pop to. So if you have someone that's devoted to ah, um, you know if you ask a question on this site you're gonna get an answer quick. It's not gonna be like a week, um, so I think that would be a crucial thing. If you're gonna be offering like, where people post, you should have someone devoted to getting back to them quick." – ISE1, Q10

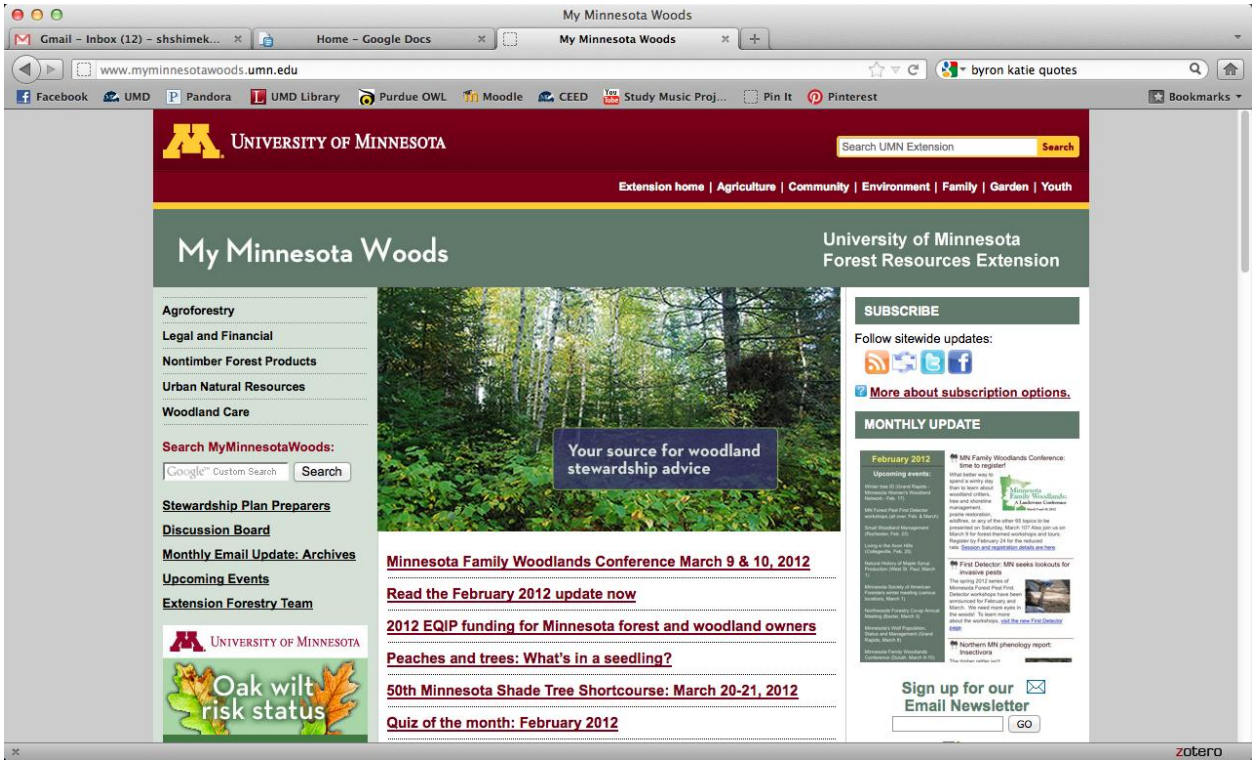

Figure 13 - My Minnesota Woods; http://www.myminnesotawoods.umn.edu

5. Social networking should not be the focus.

Most participants agreed that people are already using Facebook for a large part of their social and even professional networking, so while it is important to make sure that D2D has a presence on Facebook and other social networking sites, designers of the proposed website should put their energy into other facets of the dedicated website. Some participants saw the potential for the website to host networking activities but several felt that networking was already taking place through other avenues, whether through Facebook or in person.

> "The social networking part just sounds, it might be good just to get people connected, that may not otherwise be connected. Like, you know, we have the Facebook model of 'I'm friends with friends with friends' and we found each other because of similar interest. That's helpful, but I mean so much of that networking is person to person already anyway that it just

seems like a strange place to put energy. As far as you know, creating programming for citizen science, or creating programming for student inquiry and things like that. Although the social network part could be a component of it, but I don't know that it should be the focus; that was the one thing that I thought was really odd." – ISE3, Q29

"The networking, I just don't know if people will take the time to do it. Um, I may be wrong but, it seems like, we had a Master Naturalist chapter for instance, and it kinda flopped. Because people are just not, it's not where they want to spend their time. They want to be out doing the stuff." – ISE1, Q9

"I don't have any specific websites, when you were saying that I was thinking well what websites to I frequent; and I spend a fair amount of time on fishing forums. So that brought me back, this might be a question before, I don't mean specifically fishing forums but the dialog that can occur within a forum on a website when you get a lot of people on, you know, the same train and it's productive, which it certainly could be at I think in this setting. Forums can provide a lot of information that, and it's hard to delve out what you're going to get out of it, but it's an idea exchange and it can be really useful." – ISE6, Q53

"It would be neat if, after you took a class and you did your training, um I know it talked about doing social networks and I'm not hugely into those but what I think would be really fun is, after you took the class there were some kind of, um, yeah some kind of online blog where you can just share what you've done and even share some of your questions. And it would be nice, maybe if it's for credit, you know some kind of college credit. Because teachers get so, we're so busy, it's sometimes, personally I need some kind of uh, extrinsic motivation for me to get my work done. And so it would be nice if one aspect of getting the credit, or one aspect of getting the stipend or whatever it might be was that you make certain that you, you know that you commit in the month of September to do this project - which I guess you would need to if you were doing the monarchs or the birds, that you kind of share some of the questions that your kids are coming up with, someplace to share the concerns that you are running into. And the cool part is that, at least for me, after I've actually met people it makes it a lot more fun to share online because I know who is sharing what." – LT1, Q89

"I use Facebook myself a lot. I use it for my School Forest. Um, an awful lot." – LT2, Q100

"Again, it would be neat but it would be so close to me work that you know, I probably wouldn't do it very much. I mean, I wouldn't, it would still be work...they have webpages that they beg us to use and they work their rear end's off and they're no help to me. They just, I can't get to it. And we've done it too. The School Forest [Minnesota DNR project] has a big webpage and we have our own special log in. And I know we were supposed to have this whole thing where everybody shares their lessons from across the whole state and 'oh I found

this cool thing' and 'I found this cool thing' and I'm willing to bet that nobody uses it...And I know she tried so hard but it just..." – LT2, Q102

"So because I'm like living in this world of distance learning right now that we're starting this, sort of project right now. This is the Center for Interactive Learning and Collaboration. One of the things that I think is unique about them is that they, they're about video conferencing connections - which could be a tool that you use but doesn't have to be but one of the things that they have on their website is a collaborations page. And so you can search ways that people have collaborated, students with each other or teachers with each other or students with an organization or they have all of these ways that people have used video conferencing to collaborate in the past. Or you can post to this and say I'm looking for a collaboration about, and I think that's a pretty awesome resource to have out there. *[114a]* I just mention that because I think something like that, depending on how you structure the website or how the project, or how people enter the program, it might be that they already know who they're collaborating with, cause that's been part of the process in getting them to where they're even part of, even accessing or aware of your website. So, I dont' know if that's relevant...*[114b]* Or even in the reporting. They might be able to reach out and maybe there's a team doing the same kind of work somewhere else in the country and they can, or around the world and they can reach out and do a little mini summit and like talk about their work. *[114c]"* – ISE2, Q114

Figure 14 - Center for Interactive Learning and Collaboration; http://www.cilc.org

Recommendations for Additional Research

This study was limited by the perceptions of the potential adult leaders participating in the Driven to Discover: Enabling Authentic Inquiry through Citizen Science project. Due to the sampling methods and screening procedures of potential participants, participants' perception and definition of the inquiry process varied and may not have always aligned with the definition and process steps of inquiry employed by D2D. Experienced adult leaders who have been participating in the D2D project and leading research teams for 1-2 years were not available to this study because of the intensive assessment that they are already participating in as part of the D2D evaluation study. Further research is needed to determine if a strong grasp of the inquiry

process and experience with facilitating authentic science inquiry with youth would change the recommendations for design of the proposed website.

Participants were asked to make recommendations for the design of a website based on characteristics that were proposed and desired by D2D and by drawing comparisons to existing websites, however their suggestions are purely hypothetical in nature. Once D2D staff have designed a website based on the recommendations of this study, further research is needed to pilot test the website for usability and to determine if the hypothetical recommendations of participants in this research project are sound.

Summary

This study utilized interview protocols to conduct a needs assessment for the development of a proposed website to support connections between professional scientists and adult leaders to facilitate the authentic inquiry among youth working in citizen science research teams in the University of Minnesota Extension Driven to Discover: Authentic Inquiry through Citizen Science project. The researcher interviewed nine potential adult leaders (six informal science educators and three licensed teachers) in order to answer the following research questions:

1. How do adult leaders describe the potential for using web-based technology as a means to achieve the scientist contribution to youth-based authentic science inquiry?
2. How do adult leaders perceive plans to develop a website to facilitate the ongoing relationship of scientists, adult leaders, and youth? What do they perceive as needs and barriers for using this planned website? What website characteristics would encourage them to use this planned website?

3. What resources are adult leaders currently using to support inquiry? Are they web-based or hard copy?
4. How are adult leaders currently using the web?
5. What do adult leaders perceive as their strengths and weaknesses in the inquiry process and how might web-based technology supplement those areas?

Through an inductive coding approach to qualitative data analysis procedures, eleven primary themes and forty-nine associated sub-themes emerged from the participant responses and were used to categorize research results and recommendations for website design considerations.

In general, participants responded favorably to the creation of a proposed website to support inquiry work with youth and saw potential for the site to facilitate connections to scientists. They reported interest in aspects of the proposed website that would support inquiry science through resources and tools and help establish connections with professional scientists. Several participants expressed skepticism about the social networking features of the proposed website given the barriers of time, access to internet at project sites, and the extensive networking opportunities available either in-person or through existing social networking sites.

Summary recommendations for the design of the proposed D2D website include:

1. Clearly define the inquiry process and how the steps fit together.
2. Include content background for citizen science projects.
3. Support youth research projects.
4. Facilitate connections with scientists.

5. Facilitate sharing the research.
6. Support mentoring relationships among scientists, adult leaders, and youth.
7. Keep the design simple and organized.
8. Use visuals in a deliberate and thoughtful manner.
9. Incorporate user specific entry points or "faces" for different users.
10. Aspects of the site should be constantly maintained and updated.
11. Social networking should not be the focus.

Recommendations for future research include repeating the study with a population of participants who have a strong grasp of the inquiry process and experience facilitating inquiry with youth and pilot testing of a draft website for usability and to evaluate the effectiveness of the recommendations of this research.

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Appendices

Appendix A – Initial Contact Email

Good morning! My name is Sarah Shimek and I am a Masters of Education candidate in Environmental Education at the University of Minnesota Duluth. I am currently working on my Master's project entitled "Connecting scientists and adult leaders through technology to further authentic science inquiry by youth."

I am emailing to invite you to participate in an exploratory research study of potential adult leaders perceptions and preferences regarding the use of web-- based technology to support science inquiry with youth. You were selected as a possible participant because one of my key informants identified you as a professional who has experience working with youth and science inquiry. I have attached some background and information about the nature of this research, consent and what your participation in this research would involve.

I would like to set up a time to meet in person for a brief, approximately 30- minute, interview. The interview will consist of watching a short video which gives background about the project, approximately six questions, and some internet browsing. Just as a reminder, your participation is voluntary and you can decide to not participate at any time and it will not affect your relationship with the University of Minnesota Duluth, University of Minnesota Extension or myself.

If you have any questions about my research project, I can be reached at 218-726-6475 or shime018@d.umn.edu. You may also contact my advisor, Dr. Julie Ernst at 218-726-6761 or at jernst@d.umn.edu. If you are interested in taking part in my thesis research please reply to this email and we can set up a time to meet. If you are not interested in participating but you can think of someone who might be, I would be very grateful if you would please share their contact information. Thanks again and have a good day!

--

Sarah H. Shimek
M. Ed. Environmental Education Candidate
University of Minnesota Duluth

Research Assistant
University of Minnesota Extension, *Driven to Discover: Authentic Inquiry through Citizen Science*
University of Minnesota Extension Regional Office
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Cloquet, MN 55720
Phone: 218-726-6475

Appendix B – Interview Consent Letter

INFORMATION SHEET FOR RESEARCH

Connecting Scientists and Adult Leaders Through Technology to Further Authentic Science Inquiry by Youth

You are invited to be in a research study of adult leader preferences and barriers to using web-based technology to support science inquiry with youth. You were selected as a possible participant because of your work with youth and familiarity with science inquiry. We ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by: Sarah Shimek, M.Ed candidate in Environmental Education, at the University of Minnesota Duluth.

Procedures:

If you agree to be in this study, we would ask you to do the following things: Watch a short (approximately 5 minute) video from the University of MN Extension office, which will provide background about the Driven to Discover: Authentic Inquiry through Citizen Science project and the proposed webpage. Once you have finished watching the video, we will engage in a brief conversation (approximately 30 minutes) aimed at understanding thoughts and suggestions about the proposed webpage. During this process I will ask you to share any examples of websites that you are currently using in your work with youth and science inquiry.

Confidentiality:

The records of this study will be kept private. In any sort of report we might publish, we will not include any information that will make it possible to identify a subject. Research records will be stored securely and only researchers will have access to the records. I will be audio recording the interview and taking photographs of any websites that you share with me. No names will be used during the transcriptions of the audio recordings and your face will not appear in any photos.

Voluntary Nature of the Study:

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota or the University of Minnesota Extension Services. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:

The researcher(s) conducting this study is (are): Sarah Shimek. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact them at the University of Minnesota Extension, Cloquet Regional Office, 218-726-6462/218-726-6475, shime018@d.umn.edu. You may also contact my advisor, Dr. Julie Athman Ernst at 218-726-

6761, jernst@d.umn.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher(s), **you are encouraged** to contact the Research Subjects' Advocate Line, D528 Mayo, 420 Delaware St. Southeast, Minneapolis, Minnesota 55455; (612) 625-1650.

You will be given a copy of this information to keep for your records.

Appendix C – Interview Guide

Participant Code	
Site	
Interviewer	Sarah Shimek
Date	
Start Time	
End Time	

Introduction:

Good morning/afternoon. My name is Sarah and I am currently working on my Master's of Education in Environmental Education (EE) at the University of Minnesota Duluth. My thesis project, of which this interview is a part, explores adult leader perceptions and preferences regarding the use of web-based technology to support a relationship with scientists and youth engaged in science inquiry. I am interested in learning more about your thoughts on this subject as a potential adult group leader of a youth research team.

Consent:

In arranging this meeting you provided verbal consent to participating in this study.

I want to remind you that your participation is voluntary. You are free not to answer any question or to withdraw at any time without affecting your relationship with the University of Minnesota Duluth, the University Extension office, or me.

Thank you for participating in this project. During the next 30 minutes or so I will be asking you questions related to your perceptions about using technology to support science inquiry with youth and asking you to share examples of websites or resources that you think do a particularly good job of supporting inquiry or have characteristics you think should be included in the

potential *Driven to Discover* website. Our conversation will be tape-recorded and I will be taking pictures of example websites that you share with me. Is this okay with you?

I will also be taking notes as we go along. I want to assure you that all of the information and perspectives that you share with me today will be kept confidential. Any reported results of this research will not include information that identifies you or your organizational affiliation. I will be completing a composite analysis of the results of multiple interviews. I look forward to speaking with you today and appreciate you sharing your time and thoughts with me.

You have watched the short video from the Extension office about the Driven to Discover: Authentic Inquiry through Citizen Science project and the proposed website. What more would you like to know before we begin?

Question Guide:

Probes:
What do you mean when you say…?
Why do you think…?
Can you tell me more about…?
Can you please elaborate…?

1. To start us off, can you briefly describe your position and your typical duties within this organization?

2. Can you describe your experience working with youth around scientific inquiry?

What strategies do you use to start youth thinking about the inquiry process?

How do you feel about your understanding of the science inquiry process? Are there any areas that you feel really good at? Are there any areas where you feel unsure?

3. After watching the Extension video and thinking about how you are already engaging youth in science inquiry, how to you think the web could be used to help support inquiry?

What are your thoughts about web uses that were proposed for the Driven to Discover website?

4. If you were going to design a website to help support science inquiry and connections to professional scientists, what things would you include? What things would you leave out?

What would make you more likely to use a website to help support inquiry?

5. [Note to interviewer: Take photos of any examples of websites and write down urls.] Are there any web resources that you are currently using to support your inquiry activities with youth?

Can you show me any examples of websites that are doing a really good job of supporting inquiry or education in general?

What about examples of websites that are just interesting and easy to use?

6. Is there anything else that you think is important for me to know about doing science inquiry with youth or about web-resources that support it?

Conclusion:

[Note to interviewer] Revisit any answers that may have been unclear.

Thank you for sharing your time and thoughts with me today. Please feel free to contact me with any questions that you may have after our talk. Are you interested in learning about the results of this research?

[If yes] What would be the best way for me to contact you?

[If no] Thank you for your time. It's been very helpful to hear your thoughts and opinions.

Have a great day.

Appendix D – IRB

The IRB: Human Subjects Committee determined that the referenced study is exempt from review under federal guidelines 45 CFR Part 46.101(b) category #2 SURVEYS/INTERVIEWS; STANDARDIZED EDUCATIONAL TESTS; OBSERVATION OF PUBLIC BEHAVIOR.

Study Number: 1201E08946

Principal Investigator: Sarah Shimek

Title(s):
Connecting Scientists and Adult Leaders Through Technology to Further Authentic Science Inquiry by Youth

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This e-mail confirmation is your official University of Minnesota RSPP notification of exemption from full committee review. You will not receive a hard copy or letter.

This secure electronic notification between password protected authentications has been deemed by the University of Minnesota to constitute a legal signature.

The study number above is assigned to your research. That number and the title of your study must be used in all communication with the IRB office.

Research that involves observation can be approved under this category without obtaining consent.

SURVEY OR INTERVIEW RESEARCH APPROVED AS EXEMPT UNDER THIS CATEGORY IS LIMITED TO ADULT SUBJECTS.

This exemption is valid for five years from the date of this correspondence and will be filed inactive at that time. You will receive a notification prior to inactivation. If this research will extend beyond five years, you must submit a new application to the IRB before the study?s

expiration date.

Upon receipt of this email, you may begin your research. If you have questions, please call the IRB office at (612) 626-5654.

You may go to the View Completed section of eResearch Central at http://eresearch.umn.edu/ to view further details on your study.

The IRB wishes you success with this research.

We have created a short survey that will only take a couple of minutes to complete. The questions are basic but will give us guidance on what areas are showing improvement and what areas we need to focus on:
https://umsurvey.umn.edu/index.php?sid=94693&lang=um

Appendix E – Coding and Theme Key

Code	Theme	Description	Examples	Quotes
Current resources used for inquiry (A)				
A1	Web resources	Resources or tools that are web-based	Right now I'm spending such a large amount of time on the solar system, I'm looking at NASA, the Smithsonian, UMDStars.org. So those are the immediate, besides those that I've gotten from Frameworks, because they are, they are just top notch. – LT3, Q40	8, 21, 22, 39, 40, 50, 52, 55, 82, 97a, 98, 102, 113, 114a, 115a, 115c, 118
A2	Hard-copy resources	Resources that are not web-based	Otherwise, I am, after I pound in vocabulary through our science book, I pound the vocabulary into them and then I spend my time with Project Learning Tree and Project Wild and Project Wet. – LT2, Q97b	38, 97b
Current web use (B)				
B1	Information	Websites used for gathering information for teaching or for professional use	I haven't used this very much but it keeps getting promoted through COSEE and stuff that there's tons of data already online that people can use. This is Teaching with Great Lakes Data. – ISE2, Q116	2, 22, 23, 39, 40, 52, 53, 54, 55, 65, 82, 97a, 99, 113, 115a, 115c, 116, 117, 118
B4	Networking	Websites used for social or professional networking	I use Facebook myself a lot. I use it for my School Forest. Um, an awful lot. – LT2, Q100	23, 53, 54, 100, 114a

B3	Pleasure/Fun	Websites used for pleasure or fun	But if I look at, so Geocaching.com. We could look at that. So there's applications here, you could do all kinds of scientific stuff, it's all location-based study. It's geography, it's technology use, you know, it's making a game out of using a GPS. – ISE3, Q25	25
B4	Mapping	Web sites or tools used for mapping purposes	I think, I, I'm really big into mapping. And so I use GoogleEarth a lot, with both adults and these high school students. And they, they just, the power of that is, connecting data to locations. And so you get your specific data [here/years??] but how does that fit into the landscape scale, how do you rise up and see that bigger picture? I think that's the huge, and how do you connect with other, you know, other schools doing similar projects, and let's, let's look at what they're doing...I think that mapping function is really key. – ISE1, Q6	1, 6
Barriers to using the web for inquiry (C)				
C1	Setting/web access	Barriers to using the web for inquiry based on the setting where	So I'm thinking about this question [referring to the role of web-based technology in inquiry] and	56, 57

		education is delivered; either due to non-sequential nature of contact or a lack of access to the internet	wondering if it's, you know I think about methodology. Can I use this in, can I use this web in my methodology, the website to help further the lesson. And I think that that would be a barrier due to the nature of the facilities that I teach at; because we are, I'm an outdoor educator and the agency that I work for, we don't have computers, we don't have iPads, we don't have things to use in the field with the students or even when we come back in to use with the students. – ISE4, Q57	
C2	Time	Barriers to using the web for inquiry due to time restrictions	The networking, I just don't know if people will take the time to do it. Um, I may be wrong but, it seems like, we had a Master Naturalist chapter for instance, and it kinda flopped. Because people are just not, it's not where they want to spend their time. They want to be out doing the stuff. – ISE1, Q9	9, 97c, 98, 101, 102
C4	Perceptions/Have enough resources	Barriers to using the web based on the educators' perception that they already have sufficient resources for inquiry	I mean, it would be, cause, you know, once I've taught a lesson once - I've gone through my information, I've studied something and okay here's what I want to do, when it comes back time to do it again, I'm probably not gonna go through that kind of work	7, 43, 108a-c

			again. So I'm not gonna go back to a website, I'm not gonna go back to um, like my math book. When I went through it once last year, the teacher's manual, I don't go back to the teacher's manual anymore even. –LT2, Q108b	
C5	Adult Leader Discomfort w/Technology	Barriers to using the web due to the adult leaders' unfamiliarity with web-based tools or bias against using web-based tools	I would also say that having the adult supervisor or the science researcher being comfortable to use those web tools and actually promoting them is a huge thing. It shows the confidence of their ability to use technology, which is becoming more and more important for youth; but also that they actually use it in their daily lives and it's not just the kids saying 'well this is some dumb tool that they're making us use'. The researchers actually use them. So also finding out what scientists use in the field could be really beneficial. – ISE5, Q81	64, 81, 86, 99, 108
Inquiry process strengths (D)				
D1	Sparking interest	Self-perception of strength in getting students engaged in and excited about the inquiry process; including asking questions	I think I'm good at sparking interest because that's what a lot of my programs consist of, because they are such a short time frame, and so it's really 'what is this? what can we explore?	3, 4, 6, 26, 27, 51, 59, 60, 61, 83b, 84b, 103, 119

			where can we go from here?'… - ISE4, Q61 (excerpt)	
D2	Reflection	Self-perception of strength in engaging students in reflecting on the inquiry process or their experiences in nature	Some of the strategies we used to kind of inspire that wonder and work on reflection was journaling. And that varied a lot on the participants because some were there for a half-day, somewhere there for a full day, we did journaling, reflection, sketching, things of that nature. – ISE4, Q78	78, 103
D3	Guided inquiry/observation	Self-perception of strength in moving students through all or part of the inquiry process using a predetermined question(s)	I think it's just being that guide. I mean you get students fired up about a topic and then you, they come to you with the questions. And then you, you guide that. Show them resources. You're, you're going right along with them… - ISE1, Q18 (excerpt)	3, 5, 18, 119, 122a
D4	Moving students to ask their own questions	Self-perception of strength in engaging students to devise their own authentic inquiry questions	…But we did set up each lesson with inquiry in mind. We did the KWL model, "know, wonder, learn", and so we would start each lesson out with that. Whatever the students wondered about, what they had questions about, would kind of help guide how I would tailor the lesson to the age group and to the audience. So we had a set curricula, we talk about	51, 59, 60, 119, 121

			these key points but again, guided by the "wonder" questions. – ISE4, Q51 (excerpt)	
D5	Data collection/analysis	Self-perception of strength in guiding students through collecting and analyzing data; either to answer their own questions or as citizen science	I would say that I also am pretty comfortable at sparking interest and coming up with a testable question and even doing data analysis and looking at what the data could mean… - ISE5, Q60 (excerpt)	60
Inquiry process weaknesses (E)				
E1	Determining testable questions	Self-perception of being weak at guiding students through the process of determining which questions can be answered through research	…the hardest one for me, I don't know if it was for others, was to actually come up with a testable question. And so what is a testable question, and what are some examples of a testable question, what, you know literally, what is it, what do they look like? Because I can get, if I knew, as teachers we know if I know that I want them to get to, I can get them there. I can get them to the testable, I can get them there. But what is it? Where are we going?… - LT2, Q104 (excerpt)	103, 104, 111, 121, 123b
E2	Moving students to ask their own questions	Self-perception of being weak at guiding students to ask their own questions; moving beyond guided	…I feel less skilled at um, you know, creating the questions. Or you know, asking questions to get them to ask questions...and that's something that I	5, 27, 28, 103, 121, 122b, 123a

		inquiry	work on, but that's where I've got an opportunity for growth. – ISE3, Q27 (excerpt)	
E3	Data collection/analysis	Self-perception of being weak at guiding students through the process of collecting data to test questions and then analyzing the data that is collected	And then the, it is pretty intimidating to enter into, well to collect data for somebody else to me seems a little intimidating, because I'd want to do it right. And often, I don't beat kids up on data collection techniques, so like I just don't know what I'd do if we came back and a kid said 'I found...'…But if we were actually submitting that data, I'd feel this added pressure of, um, I don't know, just an added pressure. Like what if kids are making mistakes, what if they are misidentifying things and yeah. So anyway that would be one of the pieces that I would feel like I would need some training on or some advice on. – LT1, Q85 (excerpt)	61, 62, 84d, 85, 120
E4	Assessment of process	Self-perception of being weak at assessing the quality of learning achieved through inquiry	I think that area which I would need most help personally would be in the assessment. I really like the process and I, actually I don't really care if the kids can pass a test on it. But if they had fun doing it and I feel that they were excited about it. I, I don't really care about the other, but I	42, 84c

			do value that in some areas. So it probably is something that I should have been a little bit more attentive about that. But I don't' know that I really wanted to spend that much time on it. So that would be one of my weak areas. In today's world though, where we have to document so much it's becoming more and more necessary to assess. – LT2, Q42	
E5	Drawing conclusions/sharing or using data	Self-perception of being weak at understanding what the data could mean; determining next steps for what to do with data; where does data go once students are 'done with it'	I would say that I also am pretty comfortable at sparking interest and coming up with a testable question and even doing data analysis and looking at what the data could mean, but what I, where I think I would need help on and where I could improve is what you're gonna do with that data then. So you have this data that could actually, I don't know, conclude something, but where are you gonna focus that on?... – ISE5, Q60 (excerpt)	60, 62, 120
E6	Defining inquiry process/steps	Self-perception of being weak at understanding what activities make up the inquiry process; how they fit	I feel like I could use a better definition of inquiry science. Like so that I, it's hard for me to even answer that question because I'm not sure I know all aspects of inquiry science. – LT1,	84a

		together	Q84a	
Design Features (F)				
F1	Search feature	Ability to search the webpage using a key word or phrase	One of the other, I think it should have some kind of search feature. I hate going to websites that don't and you end up having to navigate like crazy. – ISE2, Q127	35, 70, 127, 130
F2	Video tutorials	Videos that are embedded in the site or can be downloaded; showing specific steps in a process; explaining a skill; or sharing information through a video	One of the things that I love and would love to see on your website is, even like YouTube clips; I'm a very visual learner and my students tend to be visual learners as well… - LT1, Q83a	12, 17, 66c, 83a, 86, 88b, 91, 93, 94b
F3	Ask an Expert/Scientist	Features that connect professional scientists to visitors and facilitate information exchange between the two; information about scientist background	But I think what would make it unique is that interactive component. Someone is there to answer your questions. That this is a position that somebody has, like 'I am the biology person on call to answer this question about biology', whether that's from a student or a teacher or other professional. – ISE3, Q32	16, 17, 30, 32, 44, 47, 48, 50, 69, 105, 108a, 124
F4	Lesson plans	Pre-written, complete curriculum involving inquiry	You know the other thing would be, as I think about lessons… I don't know what it would look like but something that would be a, you know the lesson title, there'd be some kind of	37, 91, 94b, 106, 108c

			brief description, and then there'd be some kind of YouTube clip to it and there'd be the pdf's right there, you know the teacher pdf, there'd be the student pdf; really easy to print off, easily, easy to access. And it would be really cool if, yeah if they were just really easy to access. [see diagram on interview notes]… - LT1, Q91 (excerpt)	
F5	Networking	Features that connect people with each other	Even something like a listserv that project leaders or whatever could be a part of; I'm part of a marine-educators listserv and so we see people throw these questions out there and then you have this huge wealth of experience that can shout about what they think or what their experience is. Having something like that, it sounds like social networking would be one way to do that too. – ISE2, Q132	9, 15, 29, 34, 46, 49, 89, 90, 92, 114a, 114b, 125, 131, 132, 138
F6	Resource Library	Information and resources available for use	You know, an indexed reference library. Everything from rubrics to lesson plans to um, publications; you know categorized in easy, easy to navigate kind of ways. – ISE3, Q31	7, 10, 31, 37, 58, 68, 88c, 106, 107, 118, 124, 125, 129, 138

F7	Data collection/analysis tools	Tools or resources that will help make it easier for non-scientists to collect or analyze data	…And the tools that I think could be useful are the actual data collection tools, or how you get the data into a usable form. Which I think can be really intimidating for folks, especially if they're not strong with their math skills or things like that. And I see this as a use for students if you could, you know, if you had a tool that was really easy to use… - ISE6, Q64 (excerpt)	64, 65, 66b, 71, 72, 74, 134a, 134b
F8	Example projects	Examples of previous inquiry projects	If you went the other way [referring to having students develop their own questions], I think something, a resource that does outline some of the, the ways people answer questions in science would be really helpful. Like these little toolkits of like here was a question and here's how it was answered using these tools. You know, whether you did like four or five different varieties to kind of help kids begin to think about designing the strategy to answer your question. – ISE2, Q137	66b, 66c, 67, 104, 134b, 136b, 137
F9	FAQ	Frequently asked questions	…You know, if everybody is asking 'Where can I find this resource' that should become, you know, something right on the frequently asked questions.	10, 35

			I mean that's something that cognitively, like 'I have a question. Oh frequently asked. Maybe it's here' you know verses having to dig for it. Perform a search either on the site or Google, Yahoo, whatever...So it's not just a guess. Some of them are gonna be canned response, like 'what is your address', 'how do I find you', 'who do I contact for this' but then the bigger questions that are gonna start to be noticeable as regular questions. – ISE3, Q35 (excerpt)	
F10	Photo gallery	Library of photos that visitors are able to download and use free of copyright restrictions; photos that are relevant to the topics of learning	…And so having a photo library with images that seem relevant; it kind of [unknown, grows?] even. I mean it could be those content areas, so like general pictures that might be useful for kids to use that they know they can use with permission, like without permission or even if as a place to, for them to upload their own images of what's going on. Something about pictures I think would be useful. And that's something that we've found to be one of the biggest challenges in our own work to is trying to source good photos… - ISE2, Q126 (excerpt)	66c, 74, 87, 88b, 126

F11	Data sharing	Feature that allows users to upload their own data and share it with others	It would be just so cool, because it, I don't know, cause it'd be fun for kids to have a way to put together a short presentation and a short clip on what they did then and a place to post that where other kids can look at it. – LT1, Q92	43, 44, 45, 46, 63, 89, 92, 93, 108a, 114c, 135b, 136a
Design Characteristics (G)				
G1	Simple	Site is not cluttered, visitor is not overwhelmed by too much information or stimulus	Probably the simpler the better. Like some of these sites get so, there's a lot of great data but it's just too much… - ISE1, Q14 (excerpt)	14, 34, 94a, 115b, 130
G2	Easy to navigate	Visitors to the site can navigate without a lot of clicking of the mouse; visitors can move from page to page and retaining a sense of where they came from and how to get back to linked pages	…And then the tabs on the top, you know, you scroll over them and the drop downs appear. You don't have to click a lot, you can just kind of, your mouse just wanders and it'll expose new things. You know but then the headings on these are very well thought out. Like, what's under 'Learn' belongs under 'Learn', 'Your Profile' everything belongs under, it all makes sense where you're going… - ISE3, Q34 (excerpt)	14, 15, 24, 31, 33, 34, 43, 115b, 117
G3	Light text (meaning not a lot of text)	Site does not have very high density of text	I'm really all about clean design that uses lots of, like pictures or graphics instead of text. There are some websites that I have been to recently where it's	130

			just a pile of words and it's, for me that's really hard to sort of know where to go or what to do and I like the sort of 'choose your own adventure' type of like, being able to really find, like dig deep down into a website. You know there's theory out there about how many layers is too much for people to actually get to where they're going… - ISE2, Q130 (excerpt)	
G4	Live/Frequently updating/interactive	Aspects of the website are live or interactive; the site is maintained regularly; features are frequently updated	…So if you have someone that's devoted to ah, um, you know if you ask a question on this site you're gonna get an answer quick. It's not gonna be like a week, um, so I think that would be a crucial thing. If you're gonna be offering like, where people post, you should have someone devoted to getting back to them quick. – ISE1, Q10 (excerpt)	10, 11, 30, 32, 35, 47, 69, 108a, 115a, 115c, 131
G5	Multiple faces	Site has one main homepage but separate sub-pages that include specific resources for specific user groups	I think you could easily have, the quick thing is having two websites. Or I mean you show up at one but 'for adults', 'for youth'. Because it really, they really are, should be different focuses. – ISE5, Q66a	66a, 74, 128
G6	Visually appealing	Site looks good, includes images that make sense	It's gotta look nice. I mean, I think more than anything, I mean, as I've worked in	33, 130

		and text that is easy to read	different organizations, you increase your traffic on your website if it's easy to navigate. If it looks good, if things make sense… - ISE3, Q33 (excerpt)	
Science Inquiry Quotes (H)				
H1	Sparking inquiry	Getting students engaged in and excited about the inquiry process; including asking questions	…And I think it's that inspiration piece, it's there. Because then, if kids want to be out there and they're really excited then they're gonna come up with great questions. But if you're kind of forcing them, they're just gonna come up with stupid questions and they're not gonna buy into the process as well. – LT1, Q95 (excerpt)	18, 67, 75, 77, 83b, 95, 133b
H2	Importance of inquiry	Why it is important for people to experience the inquiry process	In some ways I feel like your, the people that will be part of your project like this project, who are actually gonna be carrying out this inquiry with kids are the ones that sort of get it already. Like they realize it's important and want to nurture that ability in children. I think it would be really interesting to look at the, how to use something like this, particularly looking at successes with a program like this, to get the general public more excited about science inquiry and	46, 75, 76, 79, 112, 123b, 135a-c

			thinking about that science is something we do all the time. – ISE2, Q135a	
H3	Mentoring	When a more experienced person provides expertise to less experienced individuals to help them advance their careers, enhance their education, and build their networks	And if you could somehow, I think mentorship is a great way, if you could have someone that's a little more experienced with someone that's just starting out, that's a great combo. – ISE1, Q19	17, 19, 49, 75, 79, 133a, 136b
Citizen Science Quotes (I)				
I1	How data will be used	Knowing or understanding how citizen science data will be used by professional scientists	[Speaking in the context of a hypothetical water quality monitoring citizen science team] In that case, again, that whole concept of being educated and then being able to collect that data, know what's going to happen to it and how what we're doing might affect what could be happening to that stream or that river, as far as what the EPA might encourage people to do. You know that whole watershed aspect of that kind of learning for the children… - LT3, Q46 (excerpt)	13, 45, 46
I2	Barriers	Barriers to participating in citizen science	…I think that's where citizen science falls apart a lot of the times, because the leader or whoever has all the data sitting on their desk and it's just that drag	20

			to get it reported. Um, entering it in. So if there was some way to make that step happen, like, instantaneously I think that would be, I don't know if we're quite there yet but it's close. – ISE1, Q20 (excerpt)	
Role of Technology (J)				
J1	Networking	Connecting with others for social or professional purposes	And it's amazing that one thing the internet has allowed us to find is that citizen science really can be anywhere. And even if people aren't calling it that, it's happening. People watching birds in their own backyards and keeping data for the last 30 years. You may have, it may have happened but nobody was aware of it really until people started posting it on the internet. So I think that's one way that it, the web really can benefit that process. – ISE5, 80b	41, 48, 53, 54, 80b
J2	Resources	Informational resources	…And um, so I, in terms of what the web could do, you know it's certainly a resource. I mean, the internet is now the library, for, for kids. Unlike, how, what it is for me. Or what it was for me. So it's that kind of online resource they can go and find information. Now of course, we can debate all	36, 38, 80a, 80b

			day long about whether that information is correct with things like Wikipedia or whatever. But, you know as a resource definitely. – ISE3, Q36 (excerpt)	
J3	Tools	Things that are used to help accomplish a task in a more efficient or timely manner	I was just gonna say, with the big push of grant writing in technology and the increased use of iPads & iPods, like having something on your website that can be accessible to those devices in the field, cause that's one way that you can get student use in the field and educator use, um if they can kind of plug that stuff in instead of pen and paper it, plug it in on the iPad that goes directly to your site or wherever. Just thinking towards the future needs instead of here and now. – ISE4, Q72	16, 20, 50, 71, 72
Barriers to Inquiry (K)				
K1	Setting	Barriers to inquiry based on the setting where education is delivered; non-sequential contact with students	And so, given the nature of our facility, we're, we do, we typically have these one-contact experiences with kids. In my feeling, we would need to have more sustained contact with them to really support them through a longer experience. With like reflection and actually some meaning-making that's part of it. – ISE3,	58, 61, 122a, 122b,

			Q122b	
K2	Time	Barriers to inquiry based on the length of contact with students	But I feel like naturally inquiry is pretty time intensive and that's probably the area that we struggle with the most… - ISE2, Q122d (excerpt)	41, 61, 97c, 101, 108c, 119, 122c-e,
K3	Experience/qualifications in science	Barriers to doing inquiry based on the actual or perceived lack of qualifications or experience in science or with the inquiry process	So then you come to science, and there's a lot, there's a lot of teachers that are interested in science, but I think they get scared. I, you really get scared, cause they're not, and science needs to be presented, I believe at such a basic, basic level, yet not in a threatening way cause I guess if you're too condescending then they'll, you know they, 'Well we know this stuff'. But really they don't, they don't know it. And it's, so how basic... – LT2, Q109	18, 64, 85, 86, 88a, 103, 109, 110, 111, 134a

Appendix F – Participant Demographics

Pseudonym	Description	Quotes #
ISE1	Director of local Environmental Learning Center, affiliated with a state university – responsible for delivering sustainable natural resources education to landowners, college students, and in-service teachers	1-20
ISE2	Educational Director at a non-formal education center – responsible for public and school programming, online and distance learning programs, and web management; background in science; Master of Education – Environmental Education	113-138
ISE3	Graduate Assistant Project Coordinator for a Great Lakes-based educational partnership between local schools and a non-formal education center – responsible for writing curriculum and coordinating volunteer educator visits to local schools; former naturalist at a residential environmental learning center; M.Ed – EE candidate	21-38
ISE4	Non-formal educator for governmental natural resources organization – responsible for delivering primarily non-sequential, outdoor programming for youth of all ages, focused on prairie ecology; M. Ed – EE candidate	51, 52, 55-58, 60, 61, 66, 68-73, 77, 78, 82
ISE5	Non-formal educator for national environmental research center – responsible for delivering primarily non-sequential, outdoor programming for youth of all ages, focused on estuary and marine ecology; M. Ed – EE candidate	52, 54, 60, 63, 65, 66, 73, 74, 76, 80, 81, 82
ISE6	Non-formal educator for state-level angling education program – responsible for delivering primarily non-sequential, outdoor programming for youth of all ages, focused on aquatic ecosystems and fisheries management; M. Ed – EE candidate	53, 59, 62, 64, 67, 70, 75, 79
LT1	Licensed teacher, teaching 7th grade Life Science at a Private Middle/High School; class sizes 15-18 students	83-96
LT2	Licensed teacher, teaching 2nd grade all subjects at a public elementary school; coordinator of School Forest	97-112
LT3	Licensed teacher, retired from public elementary school	039-050

Appendix G – List of Web Resources

- Center for Interactive Learning and Collaboration: http://www.cilc.org/
- Cornell Lab of Ornithology: birds.cornell.edu
- Encyclopedia of Earth: http://www.eoearth.org/
- Encyclopedia of Life: http://www.eol.org
- Geocaching.com: http://www.geocaching.com/
- Groundspeak Forum: http://forums.groundspeak.com/GC/
- Lake Superior Streams.org: lakesuperiorstreams.org
- Minnesota Ornithological Union: http://moumn.org/
- Minnesota STEM Teacher Center: scimathmn.org/stemtc/
- MN DNR, Minnesota Conservation Volunteer, Young Naturalists: http://www.dnr.state.mn.us/young_naturalists/index.html
- MN DNR, School Forests in Minnesota: http://www.dnr.state.mn.us/schoolforest/index.html
- Morning Earth: http://www.morning-earth.org/
- My Minnesota Woods: myminnesotawoods.umn.edu
- NASA, Educators: http://www.nasa.gov/audience/foreducators/index.html
- National Wildlife Federation, Ranger Rick Magazine: http://www.nwf.org/Kids.aspx
- Nature Rocks: http://www.naturerocks.org/
- Save the Bay, youth page (listed under connect & youth): http://www.savebay.org/Page.aspx?pid=1372
- Smithsonian National Zoological Park: nationalzoo.si.edu
- Smithsonian: http://www.si.edu/
- Teaching with Great Lakes Data: http://greatlakeslessons.com/
- UMDstars.org: http://www.d.umn.edu/planet/
- Understanding Science: http://undsci.berkeley.edu/
- Wisconsin NatureMapping: wiscnatmap.org